

Appendix 1. Notation

Latin alphabet

<i>Symbol</i>	<i>Description</i>	<i>Introduced in Section (Formula)</i>
a	current layer half-thickness	8.3
\mathbf{A}	vector potential of a magnetic field	6.2
b	half-width of a reconnecting current layer (RCL)	8.3
\mathbf{b}	perturbation of a magnetic field	20.2.1
\mathbf{B}	magnetic field	1.2
\mathbf{B}_τ	tangential magnetic field	16.2
e, e_a	electric charge	1.2
\mathbf{e}_c	unit vector from the curvature centre	5.2
\mathcal{E}	energy of a particle	5.1
\mathbf{E}	electric field	1.2
\mathbf{E}_u	electric field in the plasma rest-frame	11.1
f_k	averaged distribution function for particles of kind k	1.1
f_{kl}	binary correlation function	2.2
f_{kln}	triple correlation function	2.3
\hat{f}_k	exact distribution function for particles of kind k	2.2
F	complex potential	14.2
\mathbf{F}, \mathbf{F}_k	force	1.1
$\langle \mathbf{F}_k \rangle_v$	mean force per unit volume	9.1
\mathbf{F}_{kl}	force density in the phase space	2.2
\mathbf{F}'	fluctuating force	2.1
g	velocity-integrated correlation function	3.2

G	gravitational constant	1.2
\mathbf{G}	energy flux density	(1.52)
\mathbf{h}	magnetic field at a wave front	20.1
Ha	Hartmann number	20.2
\mathbf{j}	electric current density	1.2
\mathbf{j}'	current density in the plasma rest-frame	11.1
\mathbf{j}_k^q	current density due to particles of kind k	9.1
\mathbf{j}_k	particle flux density in the phase space	3.1
J	electric current	19.3
k	friction coefficient	15.1
\mathbf{k}	wave vector	15.1
\mathcal{K}	kinetic energy of a particle	(5.58)
m	magnetic dipole moment	14.4
m, m_a	particle mass	1.2
M	mass of star	19.1
\mathcal{M}	magnetic moment of a particle	5.2
	magnetic energy of a system	19.1
n, n_k	number density	8.1
\mathbf{n}	unit vector along a magnetic field	5.1
N_k	number of particles of kind k	1.1
p_k	gas pressure of particles of kind k	9.1
p_m	magnetic pressure	15.1
$p_{\alpha\beta}$	pressure tensor	9.1
\mathbf{p}	particle momentum	5.1
\mathbf{P}	generalized momentum	6.2
q	generalized coordinate	6.2
\mathbf{q}	heat flux density	12.1
\mathbf{q}_k	heat flux density due to particles of kind k	9.1
Q_k	rate of energy release in a gas of particles of kind k	9.1
r_D	Debye radius	8.2
r_L	Larmor radius	5.1
\mathbf{r}_a	coordinates of a th particle	1.2
R	radius of star	14.4
R_{\perp}	guiding centre spiral radius	5.2
\mathcal{R}	rigidity of a particle	5.1
\mathbf{R}	guiding centre vector	5.2
Re	Reynolds number	12.3
Re_m	magnetic Reynolds number	12.3
s	entropy per unit mass	12.2
T	temperature	12.2
	kinetic energy of a macroscopic motion	19.1
T_B	period of the Larmor rotation	5.2
$T_{\alpha\beta}$	Maxwellian stress tensor	12.1

\mathbf{u}	relative velocity	5.1
	velocity of the centre-of-mass system	11.1
\mathbf{u}_e	mean electron velocity	11.1
\mathbf{u}_i	mean ion velocity	11.1
\mathbf{u}_k	mean velocity of particles of kind k	9.1
U	interaction potential	8.1
	volume of a fluid particle	14.2
	specific volume of a magnetic tube	19.3
U_{th}	thermal energy	19.1
\mathbf{U}	velocity of the moving reference frame	16.2
	shock speed	17.1
\mathbf{v}	macroscopic velocity of a plasma	12.2
\mathbf{v}, \mathbf{v}_a	particle velocity	1.2
\mathbf{v}_d	drift velocity	5.1
v_n	normal component of the velocity	16.2
v_x	velocity orthogonal to a discontinuity surface	16.1
\mathbf{v}'	deviation of particle velocity from its mean value	9.1
\mathbf{v}_τ	tangential velocity	16.1
v_\parallel	velocity component along the magnetic field lines	5.1
v_\perp	transversal velocity	5.1
V_A	Alfvén speed	13.1
\mathbf{V}_{gr}	group velocity of a wave	15.1
\mathbf{V}_{ph}	phase velocity of a wave	15.1
V_s	sound speed velocity	15.1
V_{Te}	mean thermal velocity of electrons	(5.54)
V_{Ti}	mean thermal velocity of ions	(5.53)
V_{Tp}	mean thermal velocity of protons	(5.55)
V_\pm	speed of a fast (slow) magnetoacoustic wave	15.1
w	probability density	2.1
w, w_k	heat function per unit mass	9.1
W	energy density of an electromagnetic field	(1.51)
X	phase space	1.1
Z	ion charge number	8.2

Greek alphabet

<i>Symbol</i>	<i>Description</i>	<i>Introduced in Section (Formula)</i>
α_B	parameter of the magnetic field inhomogeneity	5.2
α_E	parameter of the electric field inhomogeneity	5.2
β	coefficient in an expulsion force	20.3
γ	dimensionless parameter of ideal MHD	13.1
γ_g	ratio of specific heats	16.1
Γ	$6N$ -dimensional phase space	2.1
δ	dimensionless parameter of ideal MHD	12.3
ε	mean kinetic energy of a chaotic motion	12.1
	dimensionless parameter of ideal MHD	13.1
ζ	second viscosity coefficient	12.2
ζ_i	interaction parameter	3.1
ζ_p	plasma parameter	3.1
η	first viscosity coefficient (dynamic viscosity)	12.2
θ	pitch-angle	5.1
	angle between a wave vector and the magnetic field	15.1
κ_e	classical electron conductivity	8.3
λ	mean free path	8.1
$\ln \Lambda$	Coulomb logarithm	8.1
ν	collisional frequency	8.1
ν	kinematic viscosity	12.2
ν_{ei}	electron-ion mean collisional frequency	11.1
ν_{kl}	mean collisional frequency	9.1
ν_m	magnetic diffusivity	12.2
ξ	column depth	8.3
$\pi_{\alpha\beta}^{(k)}$	viscous stress tensor	9.1
$\Pi_{\alpha\beta}^*$	total momentum flux density tensor	12.2
ρ	plasma mass density	9.1
ρ_k	mass density for particles of kind k	9.1
ρ^q	electric charge density	1.2
ρ_k^q	charge density due to particles of kind k	9.1

$\boldsymbol{\rho}$	rotational motion vector	5.2
σ	isotropic electric conductivity	11.1
σ_{H}	Hall conductivity	11.1
σ_{\parallel}	conductivity parallel to the magnetic field	11.1
σ_{\perp}	conductivity perpendicular to the magnetic field	11.1
$\sigma_{\alpha\beta}^{\text{v}}$	viscous stress tensor	12.2
τ	characteristic time scale	5.2
τ_{ee}	electron collisional time	8.3
τ_{ei}	electron-ion collisional time	8.3
τ_{ii}	ion collisional time	8.3
ϕ	gravitational potential	1.2
φ	electrostatic potential	8.2
φ	angle in the spherical frame	14.4
ϕ, φ	angle in the cylindrical frame	19.2
$\hat{\varphi}_k$	deviation of the exact distribution function from an averaged distribution function	2.2
Φ	magnetic flux	14.2
	stream function	14.4
χ	deflection angle	8.1
ψ	angle to the x axis	14.4
	potential of an electric current	20.3
Ψ	potential of a current-free magnetic field	13.1
ω	wave frequency	15.1
ω_0	wave frequency in a moving frame of reference	15.1
ω_{B}	cyclotron or Larmor frequency	5.1
ω_{pl}	electron plasma frequency	8.2
Ω	gravitational energy	19.1
$\boldsymbol{\omega}$	vector of angular velocity	20.1

Appendix 2

Useful Expressions

Source formulae

Larmor frequency of a non-relativistic electron (5.11), (5.51)

$$\omega_{\text{B}}^{(\text{e})} = \frac{eB}{m_{\text{e}}c} \approx 1.76 \times 10^7 B \text{ (G)}, \text{ rad s}^{-1}.$$

Larmor frequency of a non-relativistic proton (5.52)

$$\omega_{\text{B}}^{(\text{p})} \approx 9.58 \times 10^3 B \text{ (G)}, \text{ rad s}^{-1}.$$

Larmor radius of a non-relativistic electron (5.14), (5.59)

$$r_{\text{L}}^{(\text{e})} = \frac{cp_{\perp}}{eB} \approx 5.69 \times 10^{-8} \frac{v \text{ (cm s}^{-1}\text{)}}{B \text{ (G)}}, \text{ cm}.$$

Larmor radius of a non-relativistic proton (5.14), (5.61)

$$r_{\text{L}}^{(\text{p})} \approx 1.04 \times 10^{-4} \frac{v \text{ (cm s}^{-1}\text{)}}{B \text{ (G)}}, \text{ cm}.$$

Mean thermal velocity of electrons (5.54)

$$V_{\text{Te}} = \left(\frac{3k_{\text{B}} T_{\text{e}}}{m_{\text{e}}} \right)^{1/2} \approx 6.74 \times 10^5 \sqrt{T_{\text{e}} \text{ (K)}}, \text{ cm s}^{-1}.$$

Mean thermal velocity of protons (5.55)

$$V_{\text{Tp}} \approx 1.57 \times 10^4 \sqrt{T_{\text{p}} \text{ (K)}}, \text{ cm s}^{-1}.$$

Larmor radius of non-relativistic *thermal* electrons (5.56)

$$r_{\text{L}}^{(\text{e})} = \frac{V_{\text{Te}}}{\omega_{\text{B}}^{(\text{e})}} \approx 3.83 \times 10^{-2} \frac{\sqrt{T_{\text{e}} \text{ (K)}}}{B \text{ (G)}}, \text{ cm}.$$

Larmor radius of non-relativistic *thermal* protons (5.57)

$$r_L^{(p)} = \frac{V_{Tp}}{\omega_B^{(p)}} \approx 1.64 \frac{\sqrt{T_p(\text{K})}}{B(\text{G})}, \text{ cm.}$$

Drift velocity (5.20)

$$\mathbf{v}_d = \frac{c}{e} \frac{\mathbf{F} \times \mathbf{B}}{B^2}.$$

Magnetic moment of a particle on the Larmor orbit (6.6)

$$\mathcal{M} = \frac{1}{c} JS = \frac{e \omega_B r_L^2}{2c} = \frac{p_\perp^2}{2mB} = \frac{\mathcal{E}_\perp}{B}.$$

Debye radius ($T_e = T$, $T_i = 0$ or $T_e \gg T_i$) (8.33)

$$r_D = \left(\frac{k_B T}{4\pi n e^2} \right)^{1/2}.$$

Debye radius in electron-proton thermal plasma ($T_e = T_p = T$) (8.77)

$$r_D = \left(\frac{k_B T}{8\pi e^2 n} \right)^{1/2} \approx 4.9 \left(\frac{T}{n} \right)^{1/2}, \text{ cm.}$$

Coulomb logarithm (8.75)

$$\ln \Lambda = \ln \left[\left(\frac{3k_B^{3/2}}{2\pi^{1/2} e^3} \right) \left(\frac{T_e^3}{n_e} \right)^{1/2} \right] \approx \ln \left[1.25 \times 10^4 \left(\frac{T_e^3}{n_e} \right)^{1/2} \right].$$

Electron plasma frequency (8.78)

$$\omega_{pl}^{(e)} = \left(\frac{4\pi e^2 n_e}{m_e} \right)^{1/2} \approx 5.64 \times 10^4 \sqrt{n_e}, \text{ rad s}^{-1}.$$

Thermal electron collisional time (8.80)

$$\tau_{ee} = \frac{m_e^2}{0.714 e^4 8\pi \ln \Lambda} \frac{V_{Te}^3}{n_e} \approx 4.04 \times 10^{-20} \frac{V_{Te}^3}{n_e}, \text{ s.}$$

Thermal proton collisional time (8.81)

$$\tau_{pp} = \frac{m_p^2}{0.714 e^4 8\pi \ln \Lambda} \frac{V_{Tp}^3}{n_p} \approx 1.36 \times 10^{-13} \frac{V_{Tp}^3}{n_p}, \text{ s.}$$

Electron-ion collision (energy exchange) time Section 8.3

$$\tau_{ei}(\mathcal{E}) = \frac{m_e m_i [3k_B (T_e/m_e + T_i/m_i)]^{3/2}}{e_e^2 e_i^2 (6\pi)^{1/2} 8 \ln \Lambda}.$$

Time of energy exchange between electrons and protons (8.44)

$$\tau_{ep}(\mathcal{E}) \approx 22 \tau_{pp} \approx 950 \tau_{ee}.$$

Dreicer field (8.83)

$$E_{Dr} = \frac{4\pi e^3 \ln \Lambda}{k_B} \frac{n_e}{T_e} \approx 6.54 \times 10^{-8} \frac{n_e}{T_e}, \text{ V cm}^{-1}.$$

Conductivity of magnetized plasma Section 11.3

$$\sigma_{\parallel} = \sigma = \frac{e^2 n}{m_e} \tau_{ei} \approx 2.53 \times 10^8 n (\text{cm}^{-3}) \tau_{ei} (\text{s}), \text{ s}^{-1},$$

$$\sigma_{\perp} = \sigma \frac{1}{1 + \left(\omega_B^{(e)} \tau_{ei}\right)^2}, \quad \sigma_H = \sigma \frac{\omega_B^{(e)} \tau_{ei}}{1 + \left(\omega_B^{(e)} \tau_{ei}\right)^2}.$$

Magnetic diffusivity (or viscosity) (12.49)

$$\nu_m = \frac{c^2}{4\pi\sigma} \approx 7.2 \times 10^{19} \frac{1}{\sigma}, \text{ cm}^2 \text{ s}^{-1}.$$

Magnetic Reynolds number (12.62)

$$\text{Re}_m = \frac{L^2}{\nu_m \tau} = \frac{vL}{\nu_m}$$

Alfvén speed (13.14), (13.34)

$$V_A = \frac{B}{\sqrt{4\pi\rho}} \approx 2.18 \times 10^{11} \frac{B}{\sqrt{n}}, \text{ cm s}^{-1}.$$

Sound speed in electron-proton plasma (16.98)

$$V_s = \left(\gamma_g \frac{p}{\rho}\right)^{1/2} \approx 1.66 \times 10^4 \sqrt{T(\text{K})}, \text{ cm s}^{-1}.$$

Electric field in magnetized plasma (19.71)

$$E \approx \frac{1}{c} v B \approx 10^{-8} v (\text{cm s}^{-1}) B (\text{G}), \text{ V cm}^{-1}.$$

Appendix 3. Constants

Fundamental physical constants

Speed of light	c	$2.998 \times 10^{10} \text{ cm s}^{-1}$
Electron charge	e	$4.802 \times 10^{-10} \text{ CGSE}$
Electron mass	m_e	$9.109 \times 10^{-28} \text{ g}$
Proton mass	m_p	$1.673 \times 10^{-24} \text{ g}$
Boltzmann constant	k_B	$1.381 \times 10^{-16} \text{ erg K}^{-1}$
Gravitational constant	G	$6.673 \times 10^{-8} \text{ dyne cm}^2 \text{ g}^{-2}$
Planck's constant	h	$6.625 \times 10^{-27} \text{ erg s}$

Some useful constants and units

Ampere (current)	A	$3 \times 10^9 \text{ CGSE}$
Angström (length)	Å	10^{-8} cm
Electron Volt (energy)	eV	$1.602 \times 10^{-12} \text{ erg}$
	eV	11605 K
Gauss (magnetic induction)	G	$3 \times 10^{10} \text{ CGSE}$
Henry (inductance)	H	$1.111 \times 10^{-12} \text{ s}^2 \text{ cm}^{-1}$
Ionization potential of hydrogen		13.60 eV
Joule (energy)	J	10^7 erg
Maxwell (magnetic flux)	M	$3 \times 10^{10} \text{ CGSE}$
Ohm (resistance)	Ω	$1.111 \times 10^{-12} \text{ s cm}^{-1}$
Tesla (magnetic induction)		10^4 Gauss
Volt (potential)	V	$3.333 \times 10^{-3} \text{ CGSE}$
Watt (power)	W	10^7 erg s^{-1}
Weber (magnetic flux)	Wb	10^8 Maxwell

Some astrophysical constants

Astronomical unit	AU	$1.496 \times 10^{13} \text{ cm}$
Mass of the Sun	M_\odot	$1.989 \times 10^{33} \text{ g}$

Mass of the Earth	M_E	5.98×10^{27} g
Solar radius	R_\odot	6.960×10^{10} cm
Solar surface gravity	g_\odot	2.740×10^4 cm s ⁻²
Solar luminosity	L_\odot	3.827×10^{33} erg s ⁻¹
Mass loss rate	\dot{M}_\odot	10^{12} g s ⁻¹
Rotation period of the Sun	T_\odot	26 days (at equator)

Bibliography

Each reference is cited in the Sections of the book indicated within square brackets.

- Acton, L.: 1996, Coronal structures, local and global, in *Magnetohydrodynamic Phenomena in the Solar Atmosphere: Prototypes of Stellar Magnetic Activity*, eds Y. Uchida, T. Kosugi, and H. Hudson, Dordrecht, Kluwer Academic Publ., p. 3–11. [§ 19.3]
- Akhiezer, A.I., Lyubarskii, G.Ya., and Polovin, R.V.: 1959, On the stability of shock waves in MHD, *Soviet Physics–JETP*, v. 8, No. 3, 507–512. [§ 17.2]
- Alekseyev, I.I. and Kropotkin, A.P.: 1970, Passage of energetic particles through a MHD discontinuity, *Geomagn. Aeron.*, v. 10, No. 6, 755–758. [§ 18.3]
- Alfvén, H.: 1949, On the solar origin of cosmic radiation, *Phys. Rev.*, v. 75, No. 11, 1732–1735. [§ 7.2]
- Alfvén, H.: 1950, *Cosmic Electrodynamics*, Oxford, Clarendon Press, p. 228. [Intr., § 12.2, § 13.4, § 15.2, § 20.1]
- Alfvén, H.: 1981, *Cosmic Plasma*, Dordrecht, D. Reidel Publ., p. 164. [§ 20.1]
- Alfvén, H. and Fälthammar, C.-G.: 1963, *Cosmic Electrodynamics*, Oxford, Clarendon Press, p. 228. [§ 8.1, § 8.2, § 11.1]
- Altynsev, A.T., Krasov, V.I., and Tomozov V.M.: 1977, Magnetic field dissipation in neutral current sheets, *Solar Phys.*, v. 55, No. 1, 69–81. [§ 12.3]
- Anderson, J.E.: 1963, *Magnetohydrodynamic Shock Waves*, Cambridge, Massachusetts; M.I.T. Press, p. 226. [§16.2, § 17.4]
- Andres, U.T., Polak, L.S., and Syrovatskii, S.I.: 1963, Electromagnetic expulsion of spherical bodies from a conductive fluid, *Soviet Phys.–Technical Physics*, v. 8, No. 3, 193–196. [§ 19.4, § 20.4]
- Anile, A.M.: 1989, *Relativistic Fluids and Magneto-Fluids*, Cambridge Univ. Press, p. 336. [§ 12.2]
- Antonucci, E. and Somov, B.V.: 1992, A diagnostic method for reconnecting magnetic fields in the solar corona, in *Coronal Streamers, Coronal Loops, and Coronal and Solar Wind Composition*, Proc. First SOHO Workshop, ESA SP-348, p. 293–294. [§ 8.3, § 20.4]
- Antonucci, E., Benna, C., and Somov, B.V.: 1996, Interpretation of the observed plasma ‘turbulent’ velocities as a result of reconnection in solar

- flares, *Astrophys. J.*, v. 456, No. 2, 833–839. [§ 8.3, § 20.4]
- Aschwanden, M.J.: 2002, *Particle Acceleration and Kinematics in Solar Flares: A Synthesis of Recent Observations and Theoretical Concepts*, Dordrecht, Boston, London; Kluwer Academic Publ., 227 p. [§ 4.5]
- Aschwanden, M.J., Kliem, B., Schwarz, U., et al.: 1998, Wavelet analysis of solar flare hard X-rays, *Astrophys. J.*, v. 505, No. 2, 941–956. [§ 4.5]
- Atoyan, A.M. and Aharonian, F.A.: 1999, Modelling of the non-thermal flares in the Galactic microquasar GRS 1915+105, *Mon. Not. Royal Astron. Soc.*, v. 302, No. 1, 253–276. [§ 20.1]
- Axford, W.I., Leer, E., and Skadron, G.: 1977, The acceleration of cosmic rays by shock waves, *Proc. 15th Int. Cosmic Ray Conf.*, Plovdiv, v. 11, p. 132–137. [§ 18.2]
- Bachiller, R.: 1996, Bipolar molecular outflows from young stars and proto-stars, *Ann. Rev. Astron. Astrophys.*, v. 34, 111–154. [§ 20.2]
- Bagalá, L.G., Mandrini, C.H., Rovira, M.G., et al.: 1995, A topological approach to understand a multi-loop flare, *Solar Phys.*, v. 161, No. 1, 103–121. [Intr.]
- Bai, T., Hudson, H.S., Pelling, R.M., et al.: 1983, First-order Fermi acceleration in solar flares as a mechanism for the second-step acceleration of protons and electrons, *Astrophys. J.*, v. 267, No. 1, 433–441. [§ 6.2.4]
- Balbus, S.A. and Papaloizou, J.C.B.: 1999, On the dynamical foundations of α disks, *Astrophys. J.*, v. 521, No. 2, 650–658. [§ 13.2]
- Balescu, R.: 1963, *Statistical Mechanics of Charged Particles*, London, New York, Sydney; Interscience Publ., John Wiley and Sons, Ltd., p. 477. [§ 4.1]
- Balescu, R.: 1975, *Equilibrium and Nonequilibrium Statistical Mechanics*, New York, London, Sydney, Toronto; A Wiley-Interscience Publ., John Wiley and Sons, Ltd. [§ 3.1]
- Balescu, R.: 1988, *Transport Processes in Plasmas*, Amsterdam, [§ 9.4]
- Balikhin, M., Gedalin, M., and Petrukovich, A.: 1993, New mechanism for electron heating in shocks, *Phys. Rev. Lett.*, v. 70, 1259–1262. [§ 18.3]
- Balogh, A. and Erdős, G.: 1991, Fast acceleration of ions at quasi-perpendicular shocks, *J. Geophys. Res.*, v. 96, No. A9, 15853–15862. [§ 18.3]
- Barenblatt, G.I.: 1979, *Similarity, Self-Similarity, and Intermediate Asymptotics*, New York, Consultants Bureau, Plenum. [§ 20.4]
- Bednarek, W. and Protheroe, R.J.: 1999, Gamma-ray and neutrino flares produced by protons accelerated on an accretion disc surface in active galactic nuclei, *Mon. Not. Royal Astron. Soc.*, v. 302, 373–380. [§ 13.2]
- Begelman, M.C., Blandford, R.D., and Rees, M.J.: 1984, Theory of extragalactic radio sources, *Rev. Mod. Phys.*, v. 56, No. 2, 255–351. [§ 7.3, § 13.3, § 20.1]
- Beloborodov, A.M.: 1999, Plasma ejection from magnetic flares and the X-ray spectrum of Cygnus X-1, *Astrophys. J.*, v. 510, L123–L126. [§ 13.2]
- Benz, A.: 2002, *Plasma Astrophysics: Kinetic Processes in Solar and Stellar Coronae, Second Edition*, Dordrecht, Kluwer Academic Publ., p. 299.

- [§ 3.1, § 7.1]
- Bernstein, I.B., Frieman, E.A., Kruskal, M.D., et al.: 1958, An energy principle for hydromagnetic stability problems, *Proc. Royal Soc.*, v. 244, No. A1, 17–40. [§ 19.3]
- Bertin, G.: 1999, *The Dynamics of Galaxies*, Cambridge Univ. Press, p. 448. [§ 1.3, § 9.6]
- Bethe, H.A.: 1942, Office of Scientific Research and Development, Rep. No. 445. [§ 17.1]
- Bezrodnykh, S.I. and Vlasov, V.I.: 2002, The Riemann-Hilbert problem in a complicated domain for the model of magnetic reconnection in plasma, *Computational Mathematics and Mathematical Physics*, v. 42, No. 3, 263–298. [§ 14.2.2]
- Bhatnagar, P.L., Gross, E.P., and Krook, M.: 1954, A model for collision processes in gases. 1. Small amplitude processes in charged and neutral one-component systems, *Phys. Rev.*, v. 94, No. 3, 511–525. [§ 9.7]
- Bhattacharjee, A.: 2004, Impulsive magnetic reconnection in the Earth’s magnetotail and the solar corona, *Ann. Rev. Astron. Astrophys.*, v. 42, 365–384. [§ 11.4.2]
- Bianchini, A., Della Valle, M., and Orio, M. (eds): 1995, *Cataclysmic Variables*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 540. [§ 13.2.2]
- Binney, J. and Tremaine, S.: 1987, *Galactic Dynamics*, Princeton, New Jersey; Princeton Univ. Press. [§ 3.3, § 8.5]
- Birkinshaw, M.: 1997, Instabilities in astrophysical jets, in *Advanced Topics on Astrophysical and Space Plasmas*, eds E.M. de Gouveia Dal Pino *et al.*, Dordrecht, Kluwer Academic Publ., p. 17–91. [§ 13.3.1]
- Biskamp, D. and Welter, H.: 1989, Magnetic arcade evolution and instability, *Solar Phys.*, v. 120, No. 1, 49–77. [§ 19.5]
- Blackman, E.G.: 1999, On particle energization in accretion flow, *Mon. Not. Royal Astron. Soc.*, v. 302, No. 4, 723–730. [§ 8.3]
- Blackman, E.G. and Field, G.B.: 2000, Constraints on the magnitude of α in dynamo theory, *Astrophys. J.*, v. 534, No. 2, 984–988. [§ 13.1]
- Blandford, R.D.: 1994, Particle acceleration mechanisms, *Astrophys. J., Suppl.*, v. 90, No. 2, 515–520. [§ 18.1, § 18.2]
- Bliokh, P., Sinitsin, V., and Yaroshenko, V.: 1995, *Dusty and Self-Gravitational Plasmas in Space*, Dordrecht, Kluwer Academic Publ., p. 250. [§ 1.2]
- Blokhintsev, D.I.: 1945, Moving receiver of sound, *Doklady Akademii Nauk SSSR (Soviet Physics Doklady)*, v. 47, No. 1, 22–25 (in Russian). [§ 15.2]
- Bobrova, N.A. and Syrovatskii, S.I.: 1979, Singular lines of 1D force-free field, *Solar Phys.*, v. 61, No. 2, 379–387. [§ 19.2]
- Bocquet, M., Bonazzola, S., Gourgoulhon, E., et al.: 1995, Rotating neutron star models with a magnetic field, *Astron. Astrophys.*, v. 301, No. 3, 757–775. [§ 19.1]

- Bodmer, R. and Bochsler, P.: 2000, Influence of Coulomb collisions on isotopic and elemental fractionation in the solar wind, *J. Geophys. Res.*, v. 105, No. A1, 47–60. [§ 8.4, § 10.1]
- Bogdanov, S.Yu., Frank, A.G., Kyrei, N.P., et al.: 1986, Magnetic reconnection, generation of plasma fluxes and accelerated particles in laboratory experiments, in *Plasma Astrophys.*, ESA SP-251, 177–183. [§ 12.3]
- Bogdanov, S.Yu., Kyrei, N.P., Markov, V.S., et al.: 2000, Current sheets in magnetic configurations with singular X-lines, *JETP Letters*, v. 71, No. 2, 78–84. [§ 12.3]
- Bogoliubov, N.N.: 1946, *Problems of a Dynamical Theory in Statistical Physics*, Moscow, State Technical Press (in Russian). [§ 2.4]
- Bolcato, R., Etay, J., Fautrelle, Y., et al.: 1993, Electromagnetic billiards, *Phys. Fluids*, v. 5, No. A7, 1852–1853. [§ 20.5]
- Boltzmann, L.: 1872, *Sitzungsber. Kaiserl. Akad. Wiss. Wien*, v. 66, 275–284. [§ 3.5]
- Boltzmann, L.: 1956, *Lectures on the Theory of Gases*, Moscow, Gostehizdat (in Russian). [§ 3.5]
- Bondi, H.: 1952, On spherical symmetrical accretion, *Mon. Not. Royal Astron. Soc.*, v. 112, No. 1, 195–204. [§ 13.2]
- Bontemps, S., André, P., Terebey, S., et al.: 1996, Evolution of outflow activity around low-mass embedded young stellar objects, *Astron. Astrophys.*, v. 311, 858–875. [§ 20.2]
- Born, M. and Green, H.S.: 1949, *A General Kinetic Theory of Liquids*, Cambridge, Cambridge Univ. Press. [§ 2.4]
- Braginskii, S.I.: 1965, Transport processes in plasma, in *Reviews of Plasma Physics*, ed. M. Leontovich, New York, Consultants Bureau, v. 1, 205–311. [§ 9.5, § 10.5, § 11.4.2]
- Bridgman, P.W.: 1931, *Dimensional Analysis*, New Haven, Yale Univ. Press, p. 113. [§ 20.4]
- Broderick, A., Prakash, M., and Lattimer, J.M.: 2000, The equation of state of neutron star matter in strong magnetic fields, *Astrophys. J.*, v. 537, No. 1, 351–367. [§ 19.1]
- Brown, J.C.: 1971, The deduction of energy spectra of non-thermal electrons in flares from the observed dynamic spectra of hard X-ray bursts, *Solar Phys.*, v. 18, No. 2, 489–502. [§ 4.3, § 8.1]
- Brown, J.C.: 1972, The directivity and polarization of thick target X-ray bremsstrahlung from flares, *Solar Phys.*, v. 26, No. 2, 441–459. [§ 4.4]
- Brown, J.C., McArthur, G.K., Barrett, R.K., et al.: 1998a, Inversion of the thick-target bremsstrahlung spectra from non-uniformly ionised plasmas, *Solar Phys.*, v. 179, No. 2, 379–404. [§ 4.5]
- Brown, J.C., Conway, A.J., and Aschwanden, M.J.: 1998b, The electron injection function and energy-dependent delays in thick-target hard X-rays, *Astrophys. J.*, v. 509, No. 2, 911–917. [§ 4.5]
- Brown, J.C., Emslie, A.G., and Kontar, E.P.: 2003, The determination and use of mean electron flux spectra in solar flares, *Astrophys. J.*, v. 595,

- No. 2, L115–L117. [§ 4.5]
- Bykov, A.M., Chevalier, R.A., Ellison, D.C., et al.: 2000, Nonthermal emission from a supernova remnant in a molecular cloud, *Astrophys. J.*, v. 538, No. 1, 203–216. [§ 8.4.1]
- Cadjan, M.G. and Ivanov, M.F.: 1999, Langevin approach to plasma kinetics with collisions, *J. Plasma Phys.*, v. 61, No. 1, 89–106. [§ 3.4]
- Cai, H.J. and Lee, L.C.: 1997, The generalized Ohm’s law in collisionless reconnection, *Phys. Plasmas*, v. 4, No. 3, 509–520. [§ 1.2]
- Camenzind, M.: 1995, Magnetic fields and the physics of active galactic nuclei, *Rev. Mod. Astron.*, v. 8, 201–233. [§ 13.3]
- Campbell, C.G.: 1997, *Magnetohydrodynamics of Binary Stars*, Dordrecht, Kluwer Academic Publ., p. 306. [§ 13.2]
- Cercignani, C.: 1969, *Mathematical Methods in Kinetic Theory*, MacMillan. [§ 3.5]
- Chakrabarti, S.K. (ed.): 1999, *Observational Evidence for Black Holes in the Universe*, Dordrecht, Kluwer Academic Publ., p. 399. [§ 8.3]
- Chandrasekhar, S.: 1943a, Stochastic problems in physics and astronomy, *Rev. Mod. Phys.*, v. 15, No. 1, 1–89. [§ 3.1, § 8.1, § 8.3]
- Chandrasekhar, S.: 1943b, Dynamical friction. 1. General considerations, *Astrophys. J.*, v. 97, No. 1, 255–262. [§ 8.3, § 8.5]
- Chandrasekhar, S.: 1943c, Dynamical friction. 2. The rate of escape of stars from clusters and the evidence for the operation of dynamic friction, *Astrophys. J.*, v. 97, No. 1, 263–273. [§ 8.3, § 8.5]
- Chandrasekhar, S.: 1981, *Hydrodynamic and Hydromagnetic Stability*, New York, Dover Publ., p. 654. [§ 19.1, § 19.3]
- Chandrasekhar, S. and Fermi, E.: 1953, Problems of gravitational stability in the presence of a magnetic field, *Astrophys. J.*, v. 118, No. 1, 116–141. [§ 19.1]
- Cherenkov, P.A.: 1934, *C. R. Ac. Sci. U.S.S.R.*, v. 8, 451 (in Russian). [§ 7.4]
- Cherenkov, P.A.: 1937, Visible radiation produced by electrons moving in a medium with velocities exceeding that of light, *Phys. Rev.*, v. 52, 378–379. [§ 7.4]
- Chernov, A.A. and Yan’kov, V.V.: 1982, Electron flow in low-density pinches, *Soviet J. Plasma Phys.*, v. 8, No. 5, 522–528. [§ 20.4]
- Chew, G.F., Goldberger, M.L., and Low, F.E.: 1956, The Boltzmann equation and the one-fluid hydromagnetic equations in the absence of particle collisions, *Proc. Royal Soc. London*, v. A236, No. 1, 112–118. [§ 11.5.1, § 16.4]
- Choudhuri, A.R.: 1998, *The Physics of Fluids and Plasmas: An Introduction for Astrophysicists*, Cambridge, Cambridge Univ. Press, p. 427. [Intr., § 19.1]
- Clausius, R.: 1870, On a mechanical theorem applicable to heat, *Philosophical Magazine* (Series 4), v. 40, No. 1, 122–127. [§ 19.1]

- Cole, J.D. and Huth, J.H.: 1959, Some interior problems of hydromagnetics, *Phys. Fluids*, v. 2, No. 6, 624–626. [§ 14.5]
- Collins, G.W.: 1978, *The Virial Theorem in Stellar Astrophysics*, Tucson, Pachart. [§ 19.1]
- Courant, R. and Friedrichs, K.O.: 1985, *Supersonic Flow and Shock Waves*, New York, Berlin, Heidelberg, Tokyo; Springer-Verlag, p. 464. [§ 17.1]
- Cowling, T.G.: 1976, *Magnetohydrodynamics*, Bristol, Adam Hilger, p. 135. [§ 11.6]
- Crooker, N., Joselyn, J.A., and Feynman, J. (eds): 1997, *Coronal Mass Ejections*, Washington, Amer. Geophys. Un., p. 299. [Intr.]
- Cuperman, S. and Dryer, M.: 1985, On the heat conduction in multicomponent, non-Maxwellian spherically symmetric solar wind plasmas, *Astrophys. J.*, v. 298, 414–420. [§ 9.5]
- Dadhich, N. and Kembhavi, A. (eds): 2000, *The Universe: Visions and Perspectives*, Dordrecht, Kluwer Academic Publ., p. 346. [§ 1.3]
- Darwin, C.: 1949, Source of the cosmic rays, *Nature*, v. 164, 1112–1114. [§ 18.1]
- Davis, L.Jr.: 1956, Modified Fermi mechanism for the acceleration of cosmic rays, *Phys. Rev.*, v. 101, 351–358. [§ 6.2.4]
- de Hoffmann, F. and Teller, E.: 1950, MHD shocks, *Phys. Rev.*, v. 80, No. 4, 692–703. [§ 16.2, § 16.5]
- de Martino, D., Silvotti, R., Solheim, J.-E., et al. (eds): 2003, *White Dwarfs*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 429. [§ 1.4, § 3.5]
- Debye, P. and Hückel, E.: 1923, *Phys. Zs.*, v. 24, 185. [§ 8.2]
- Decker, R.B.: 1983, Formation of shock-spike events in quasi-perpendicular shocks, *J. Geophys. Res.*, v. 88, No. A12, 9959–9973. [§ 18.3]
- Decker, R.B.: 1993, The role of magnetic loops in particle acceleration at nearly perpendicular shocks, *J. Geophys. Res.*, v. 98, No. A1, 33–46. [§ 18.3]
- Decker, R.B. and Vlahos, L.: 1986, Numerical studies of particle acceleration at turbulent, oblique shocks with an application to prompt ion acceleration during solar flares, *Astrophys. J.*, v. 306, No. 2, 710–729. [§ 18.3.3]
- Diakonov, S.V. and Somov, B.V.: 1988, Thermal electrons runaway from a hot plasma during a flare in the reverse-current model and their X-ray bremsstrahlung, *Solar Phys.*, v. 116, No. 1, 119–139. [§ 4.5, § 8.4]
- Di Matteo, T., Celotti, A., and Fabian, A.C.: 1999, Magnetic flares in accretion disc coronae and the spectral states of black hole candidates: the case of GX339-4, *Mon. Not. Royal Astron. Soc.*, v. 304, 809–820. [§ 13.2]
- Di Matteo, T., Quataert, E., Allen, S.W., et al.: 2000, Low-radiative-efficiency accretion in the nuclei of elliptical galaxies, *Mon. Not. Royal Astron. Soc.*, v. 311, No. 3, 507–521. [§ 13.2]
- Di Matteo, T., Johnstone, R.M., Allen, S.W., et al.: 2001, Accretion onto nearby supermassive black holes: *Chandra* constraints on the dominant cluster galaxy NGC 6166, *Astrophys. J.*, v. 550, No. 1, L19–L23. [§ 13.2]

- Dokuchaev, V.P.: 1964, Emission of magnetoacoustic waves in the motion of stars in cosmic space, *Soviet Astronomy-AJ*, v. 8, No. 1, 23–31. [§ 15.4]
- Drake, J.F. and Kleva R.G.: 1991, Collisionless reconnection and the sawtooth crash, *Phys. Rev. Lett.*, v. 66, No. 11, 1458–1461. [§ 11.2]
- Dreicer, H.: 1959, Electron and ion runaway in a fully ionized gas, *Phys. Rev.*, v. 115, No. 2, 238–249. [§ 8.4, § 10.1]
- Duijveman, A., Somov, B.V., and Spektor, A.R.: 1983, Evolution of a flaring loop after injection of fast electrons, *Solar Phys.*, v. 88, No. 1, 257–273. [§ 8.3]
- Dyer, K.K., Reynolds, S.R., Borkowski, K.J., et al.: 2001, Separating thermal and nonthermal X-rays in supernova remnants. I. Total fits to SN 1006 AD, *Astrophys. J.*, v. 551, No. 1, 439–453. [§ 18.2]
- D'yakov, S.P.: 1954, *Zhurnal Exper. Teor. Fiz.*, v. 27, 288–297 (in Russian). [§ 17.5]
- Eichler, D.: 1979, Particle acceleration in solar flares by cyclotron damping of cascading turbulence, *Astrophys. J.*, v. 229, No. 1, 413–418. [§ 6.2.4]
- Elsasser, W.M.: 1956, Hydromagnetic dynamo theory, *Rev. Mod. Phys.*, v. 28, No. 2, 135–163. [§ 13.1, § 20.1]
- Erdős, G. and Balogh, A.: 1994, Drift acceleration at interplanetary shocks, *Astrophys. J., Suppl.*, v. 90, No. 2, 553–559. [§ 18.3]
- Falle, S.A. and Komissarov, S.S.: 2001, On the inadmissibility of non-evolutionary shocks, *J. Plasma Phys.*, v. 65, No. 1, 29–58. [§ 16.3]
- Fedoryuk, V.M.: 1985, *Ordinary Differential Equations*, Moscow, Nauka (in Russian). [§ 17.4.1]
- Feldman, W.C., Bame, S.J., Gary, S.P., et al.: 1982, Electron heating within the Earth's bow shock, *Phys. Rev. Lett.*, v. 49, 199–202. [§ 18.3]
- Fermi, E.: 1949, On the origin of cosmic radiation, *Phys. Rev.*, v. 75, 1169–1174. [§ 6.2.4]
- Fermi, E.: 1954, Galactic magnetic fields and the origin of cosmic radiation, *Astrophys. J.*, v. 119, No. 1, 1–6. [§ 6.2.4]
- Feroci, M., Hurley, K., Duncan, R.C., et al.: 2001, The giant flare of 1998 August 27 from SGR 1900+14. 1. An interpretive study of *Bepposax* and *Ulysses* observations, *Astrophys. J.*, v. 549, No. ?, 1021–1038. [§ 19.1]
- Field, G.B.: 1965, Thermal instability, *Astrophys. J.*, v. 142, No. 2, 531–567. [§ 8.3]
- Fokker, A.D.: 1914, Die mittlere Energie rotieren der elektrischer Dipole im Strahlungsfeld, *Ann. der Physik*, v. 43, No. 5, 810–820. [§ 3.1]
- Fox, D.C. and Loeb, A.: 1997, Do the electrons and ions in X-ray clusters share the same temperature? *Astrophys. J.*, v. 491, No. 2, 459–466. [§ 8.3]
- Galeev, A.A., Rosner, R., and Vaiana, G.S.: 1979, Structured coronae of accretion discs, *Astrophys. J.*, v. 229, No. 1, 318–326. [§ 13.2]
- Gedalin, M. and Griv, E.: 1999, Collisionless electrons in a thin high Mach number shocks: dependence on angle and β , *Ann. Geophysicae*, v. 17, No. 10, p. 1251–1259. [§ 16.4, § 18.3]

- Gel'fand, I.M.: 1959, Some problems of the theory of quasilinear equations, *Usp. Mat. Nauk*, v. 14, No. 2, 87–158 (in Russian). [§ 17.1]
- Gerbeth, G., Thess, A., and Marty, P.: 1990, Theoretical study of the MHD flow around a cylinder in crossed electric and magnetic fields, *Eur. J. Mech., B/Fluids*, v. 9, No. 3, 239–257. [§ 19.4, § 20.3]
- Germain, P.: 1960, Shock waves and shock-wave structure in MHD, *Rev. Mod. Phys.*, v. 32, No. 4, 951–958. [§ 17.4]
- Giacalone, J. and Ellison, D.C.: 2000, Three-dimensional numerical simulations of particle injection and acceleration at quasi-perpendicular shocks, *J. Geophys. Res.*, v. 105, No. A6, 12541–12556. [§ 18.1, § 18.3]
- Gieseler, U.D.J., Kirk, J.G., Gallant, Y.A., et al.: 1999, Particle acceleration at oblique shocks and discontinuities of the density profile, *Astron. Astrophys.*, v. 435, No. 1, 298–306. [§ 18.2]
- Gilman, P.A.: 2000, Fluid dynamics and MHD of the solar convection zone and tachocline, *Solar Phys.*, v. 192, No. 1, 27–48. [§ 20.1]
- Ginzburg, V.L. and Syrovatskii, S.I.: 1964, *The Origin of Cosmic Rays*, Oxford, Pergamon Press. [§ 5.1]
- Ginzburg, V.L. and Syrovatskii, S.I.: 1965, Cosmic magneto-bremsstrahlung (synchrotron) radiation, *Annual Rev. Astron. Astrophys.*, v. 3, 297–350. [§ 5.3]
- Ginzburg, V.L. and Zheleznyakov, V.V.: 1958, On the possible mechanisms of sporadic solar radio emission, *Soviet Astronomy-AJ*, v. 2, No. 5, 653–668. [§ 7.1]
- Ginzburg, V., Landau, L., Leontovich, M., et al.: 1946, On the insolvency of the A.A. Vlasov works on general theory of plasma and solid-state matter, *Zhur. Eksp. Teor. Fiz.*, v. 16, No. 3, 246–252 (in Russian). [§ 3.1]
- Giovanelli, R.G.: 1949, Electron energies resulting from an electric field in a highly ionized gas, *Phil. Mag.*, Seventh Series, v. 40, No. 301, 206–214. [§ 8.4]
- Gisler, G. and Lemons, D.: 1990, Electron Fermi acceleration in collapsing magnetic traps: Computational and analytical models, *J. Geophys. Res.*, v. 95, No. A9, 14925–14938. [§ 18.3]
- Glasstone, S. and Loveberg, R.H.: 1960, *Controlled Thermonuclear Reactions*, Princeton, Van Nostrand, p. 523. [Intr.]
- Goldreich, P. and Sridhar, S.: 1997, Magneto-hydrodynamic turbulence revisited, *Astrophys. J.*, v. 485, No. 2, 680–688. [§ 7.2]
- Goldston, R.J. and Rutherford, P.H.: 1995, *Introduction to Plasma Physics*, Bristol, Inst. of Phys. Publ., p. 492. [Intr.]
- Gombosi, T.I.: 1999, *Physics of the Space Environment*, Cambridge Univ. Press, p. 339. [§ 18.2]
- Gorbachev, V.S. and Kel'ner, S.R.: 1988, Formation of plasma condensations in fluctuating strong magnetic field, *Soviet Physics-JETP*, v. 67, No. 9, 1785–1790. [§ 14.4]
- Grant, H.L., Stewart, R.W., and Moilliet, A.: 1962, *J. Fluid Mech.*, v. 12, 241–248. [§ 7.2]

- Gurevich, A.V.: 1961, On the theory of runaway electrons, *Soviet Physics-JETP*, v. 12, No. 5, 904–912. [§ 8.4]
- Gurevich, A.V. and Istomin, Y.N.: 1979, Thermal runaway and convective heat transport by fast electrons in a plasma, *Soviet Physics-JETP*, v. 50, No. 3, 470–475. [§ 8.4]
- Gurevich, A.V. and Zhivlyuk, Y.N.: 1966, Runaway electrons in a non-equilibrium plasma, *Soviet Physics-JETP*, v. 22, No. 1, 153–159. [§ 4.5]
- Hattori, M. and Umetsu, K.: 2000, A possible route to spontaneous reduction of the heat conductivity by a temperature gradient-driven instability in electron-ion plasmas, *Astrophys. J.*, v. 533, No. 1, 84–94. [§ 8.3]
- Hawley, J.F. and Balbus, S.A.: 1999, Instability and turbulence in accretion discs, in *Numerical Astrophysics*, eds S.M. Miyama et al., Dordrecht, Kluwer Academic Publ., p. 187–194. [§ 13.2]
- Hawley, J.F., Gammie, C.F., and Balbus, S.A.: 1995, Local three-dimensional magnetohydrodynamic simulations of accretion disks, *Astrophys. J.*, v. 440, No. 2, 742–763. [§ 13.2]
- Hénoux, J.-C. and Somov, B.V.: 1987, Generation and structure of the electric currents in a flaring activity complex, *Astron. Astrophys.*, v. 185, No. 1, 306–314. [§ 20.2]
- Hénoux, J.-C. and Somov, B.V.: 1991, The photospheric dynamo. 1. Magnetic flux-tube generation, *Astron. Astrophys.*, v. 241, No. 2, 613–617. [§ 11.1, § 20.2]
- Hénoux, J.-C. and Somov, B.V.: 1997, The photospheric dynamo. 2. Physics of thin magnetic flux tubes, *Astron. Astrophys.*, v. 318, No. 3, 947–956. [§ 11.1]
- Hirovani, K. and Okamoto, I.: 1998, Pair plasma production in a force-free magnetosphere around a supermassive black hole, *Astrophys. J.*, v. 497, No. 2, 563–572. [§ 7.3, § 11.5.2]
- Hollweg, J.V.: 1986, Viscosity and the Chew-Goldberger-Low equations in the solar corona, *Astrophys. J.*, v. 306, No. 2, 730–739. [§ 9.5, § 10.5]
- Holman, G.D.: 1995, DC electric field acceleration of ions in solar flares, *Astrophys. J.*, v. 452, No. 2, 451–456. [§ 8.4]
- Horiuchi, R. and Sato, T.: 1994, Particle simulation study of driven reconnection in a collisionless plasma, *Phys. Plasmas*, v. 1, No. 11, 3587–3597. [§ 1.2, § 11.2]
- Hoshino, M., Stenzel, R.L., and Shibata, K. (eds): 2001, *Magnetic Reconnection in Space and Laboratory Plasmas*, Tokyo, Terra Scientific Publ. Co., p. 693. [§ 13.1.3]
- Hoyng, P., Brown, J.C., and van Beek, H.F.: 1976, High time resolution analysis of solar hard X-ray flares observed on board the ESRO TD-1A satellite, *Solar Phys.*, v. 48, No. 2, 197–254. [§ 4.5]
- Hubrig, S., North, P., and Mathys, G.: 2000, Magnetic Ap stars in the Hertzsprung-Russell diagram, *Astrophys. J.*, v. 539, No. 1, 352–363. [§ 19.1]

- Hudson, P.D.: 1965, Reflection of charged particles by plasma shocks, *Mon. Not. Royal Astron. Soc.*, v. 131, No. 1, 23–50. [§ 18.3]
- Innes, D.E., Inhester, B., Axford, W.I., et al.: 1997, Bi-directional jets produced by reconnection on the Sun, *Nature*, v. 386, 811–813. [§ 8.3]
- Iordanskii, S.V.: 1958, On compression waves in MHD, *Soviet Physics–Doklady*, v. 3, No. 4, 736–738. [§ 16.2]
- Iroshnikov, P.S.: 1964, Turbulence of a conducting fluid in a strong magnetic field, *Soviet Astronomy–AJ.*, v. 7, No. 4, 566–571. [§ 7.2]
- Jaroschek, C.H., Treumann, R.A., Lesch, H., et al.: 2004, Fast reconnection in relativistic pair plasmas: Analysis of particle acceleration in self-consistent full particle simulations, *Phys. Plasm.*, v. 11, No. 3, 1151–1163. [§ 7.3]
- Jeans, J.: 1929, *Astronomy and Cosmogony*, Cambridge Univ. Press. [§ 8.1]
- Jones, F.C. and Ellison D.C.: 1991, The plasma physics of shock acceleration, *Space Sci. Rev.*, v. 58, No. 3, 259–346. [§ 18.1, § 18.2, § 18.3]
- Jones, M.E., Lemons, D.S., Mason, R.J., et al.: 1996, A grid-based Coulomb collision model for PIC codes, *J. Comput. Phys.*, v. 123, No. 1, 169–181. [§ 3.4]
- Kadomtsev, B.B.: 1960, Convective instability of a plasma, in *Plasma Physics and the Problem of Controlled Thermonuclear Reactions*, ed. M.A. Leontovich, London, Oxford; Pergamon Press, v. 4, p. 450–453. [§ 19.3]
- Kadomtsev, B.B.: 1966, Hydrodynamic stability of a plasma, in *Reviews of Plasma Physics*, ed. M.A. Leontovich, New York, Consultants Bureau, v. 2, p. 153–198. [§ 19.3]
- Kadomtsev, B.B.: 1976, *Collective Phenomena in Plasma*, Moscow, Nauka, p. 238 (in Russian). [§ 7.1]
- Kandrup, H.E.: 1998, Collisionless relaxation in galactic dynamics and the evolution of long-range order, *Annals of the New York Acad. of Sci.*, v. 848, 28–47. [§ 3.3]
- Kikuchi, H.: 2001, *Electrohydrodynamics in Dusty and Dirty Plasmas*, Dordrecht, Kluwer Academic Publ., p. 207. [§ 1.2]
- Kirkwood, J.G.: 1946, The statistical mechanical theory of transport processes. I. General theory, *J. Chem. Phys.*, v. 14, 180–201. [§ 2.4]
- Kittel, C.: 1995, *Introduction to Solid State Physics*, 7th edition, John Wiley. [§ 1.4, § 3.5]
- Kivelson, M.G. and Russell, C.T. (eds): 1995, *Introduction to Space Physics*, Cambridge, Cambridge Univ. Press, p. 568. [§ 4.1, § 6.2.4]
- Klimontovich, Yu.L.: 1975, *Kinetic Theory of Non-ideal Gas and Non-ideal Plasma*, Moscow, Nauka, p. 352 (in Russian). [§ 2.4]
- Klimontovich, Yu.L.: 1986, *Statistical Physics*, New York, Harwood Academic. [Intr., § 2.4, § 3.1]
- Klimontovich, Yu.L.: 1998, Two alternative approaches in the kinetic theory of a fully ionized plasma, *J. Plasma Phys.*, v. 59, No. 4, 647–656. [§ 3.1]
- Klimontovich, Yu.L. and Silin, V.P.: 1961, On magnetic hydrodynamics for a non-isothermal plasma without collisions, *Soviet Physics–JETP*, v. 40, 1213–1223. [§ 11.5, § 16.4]

- Kogan, M.N.: 1967, *Dynamics of a Dilute Gas*, Moscow, Nauka (in Russian). [§ 3.5]
- Koide, S., Shibata, K., and Kudoh, T.: 1999, Relativistic jet formation from black hole magnetized accretion discs, *Astrophys. J.*, v. 522, 727–752. [§ 12.2, § 13.3]
- Kolmogorov, A.N.: 1941, The local structure of turbulence in incompressible viscous fluid for very large Reynolds numbers, *C.R. Acad. Sci. USSR*, v. 30, 201–206. [§ 7.2]
- Korchak, A.A.: 1971, On the origin of solar flare X-rays, *Solar Phys.*, v. 18, No. 2, 284–304. [§ 8.1]
- Korchak, A.A.: 1980, Coulomb losses and the nuclear composition of the solar flare accelerated particles, *Solar Phys.*, v. 66, No. 1, 149–158. [§ 8.4]
- Kotchine, N.E.: 1926, Rendiconti del Circolo Matematico di Palermo, v. 50, 305–314. [§ 17.1]
- Kovalev, V.A. and Somov, B.V.: 2002, On the acceleration of solar-flare charged particles in a collapsing magnetic trap with an electric potential, *Astronomy Letters*, v. 28, No. 7, 488–493. [§ 8.1]
- Kraichnan, R.H.: 1965, Inertial-range spectrum of hydromagnetic turbulence, *Phys. Fluids*, v. 8, No. 7, 1385–1389. [§ 7.2]
- Krall, N.A. and Trivelpiece, A.W.: 1973, *Principles of Plasma Physics*, New York, McGraw-Hill Book Co. [§ 9.5]
- Krymskii, G.F.: 1977, A regular mechanism for the acceleration of charged particles on the front of a shock wave, *Soviet Phys. Dokl.*, v. 22, No. 6, 327–328. [§ 18.2]
- Kudriavtsev, V.S.: 1958, Energetic diffusion of fast ions in equilibrium plasma, *Soviet Physics-JETP*, v. 7, No. 6, 1075–1079. [§ 4.1]
- Kulikovskii, A.G. and Liubimov, G.A.: 1961, On the structure of an inclined MHD shock wave, *Appl. Math. Mech.*, v. 25, No. 1, 171–179. [§ 17.4]
- Kunkel, W.B.: 1984, Generalized Ohm's law for plasma including neutral particles, *Phys. Fluids*, v. 27, No. 9, 2369–2371. [§ 11.1]
- Lahav, O., Terlevich, E., and Terlevich, R.J. (eds): 1996, *Gravitational Dynamics*, Cambridge, UK; Cambridge Univ. Press, p. 270. [§ 1.3]
- Lancellotti, C. and Kiessling, M.: 2001, Self-similar gravitational collapse in stellar dynamics, *Astrophys. J.*, v. 549, L93–L96. [§ 3.5]
- Landau, L.D.: 1937, Kinetic equation in the case of Coulomb interaction, *Zh. Exp. Teor. Fiz.*, v. 7, No. 1, 203–212 (in Russian). [§ 3.1]
- Landau, L.D.: 1946, On the vibrations of the electron plasma, *J. Phys. USSR*, v. 10, No. 1, 25–30. [§ 3.1, § 7.1]
- Landau, L.D. and Lifshitz, E.M.: 1959a, *Fluid Mechanics*, Oxford, London; Pergamon Press, p. 536. [§ 12.2, § 15.4, § 16.1, § 16.2.2, § 20.2]
- Landau, L.D. and Lifshitz, E.M.: 1959b, *Statistical Physics*, London, Paris; Pergamon Press, p. 478. [§ 1.1.5, § 1.4, § 3.5, § 16.5]
- Landau, L.D. and Lifshitz, E.M.: 1975, *Classical Theory of Field*, 4th edition, Oxford, Pergamon Press, p. 374. [§ 1.2, § 5.1, § 5.3, § 6.2.1, § 7.4, § 13.4, § 18.4, § 19.1]

- Landau, L.D. and Lifshitz, E.M.: 1976, *Mechanics*, 3rd edition, Oxford, Pergamon Press, p. 165. [§ 1.1.5, § 1.4, § 6.1, § 8.1, § 19.1]
- Landau, L.D., Lifshitz, E.M., and Pitaevskii, L.P.: 1984, *Electrodynamics of Continuous Media*, Oxford, New York; Pergamon Press, p. 460. [§ 11.4.2, § 16.2, § 17.3]
- Langmuir, I.: 1928, *Proc. Nat. Acad. Sci. U.S.A.*, v. 14, 627. [§ 3.2.2]
- Larrabee, D.A., Lovelace, R.V.E., and Romanova, M.M.: 2003, Lepton acceleration by relativistic collisionless magnetic reconnection, *Astrophys. J.*, v. 586, No. 1, 72–78. [§ 7.3]
- Lavrent'ev, M.A. and Shabat, B.V.: 1973, *Methods of the Theory of Complex Variable Functions*, Moscow, Nauka, p. 736 (in Russian). [§ 14.2]
- Lax, P.: 1957, Hyperbolic systems of conservation laws, *Comm. Pure Appl. Math.*, v. 10, No. 4, 537–566. [§ 17.1]
- Lax, P.: 1973, *Hyperbolic Systems of Conservation Laws and the Mathematical Theory of Shock Waves*, SIAM. [§ 17.1]
- Leenov, D. and Kolin, A.: 1954, Theory of electromagnetophoresis. 1. MHD forces experienced by spheric and cylindrical particles, *J. Chemical Phys.*, v. 22, No. 4, 683–688. [§ 20.4]
- Leith, C.E.: 1967, Diffusion approximation to inertial energy transfer in isotropic turbulence, *Phys. Fluids*, v. 10, No. 7, 1409–1416. [§ 7.2]
- Leontovich, M.A. (ed.): 1960, *Plasma Physics and the Problem of Controlled Thermonuclear Reactions*, London, Oxford, New York, Paris; Pergamon Press, v. 1–4. [Intr.]
- Lesch, H. and Pohl, M.: 1992, A possible explanation for intraday variability in active galactic nuclei, *Astron. Astrophys.*, v. 254, No. 1, 29–38. [§ 13.2]
- Lieberman, M.A.: 1978, On actuating shock waves in a completely ionized plasma, *Soviet Physics-JETP*, v. 48, No. 5, 832–840. [§ 16.2, § 17.4]
- Liboff, R.: 2003, *Kinetic Theory: Classical, Quantum, and Relativistic Descriptions*, Heidelberg, New York; Springer, p. 571. [Intr.]
- Lichnerowicz, A.: 1967, *Relativistic Hydrodynamics and Magnetohydrodynamics*, New York, Amsterdam, Benjamin, p. 196. [§ 12.2]
- Lifshitz, E.M. and Pitaevskii, L.P.: 1981, *Physical Kinetics*, Oxford, New York, Beijing, Frankfurt; Pergamon Press, p. 452. [§ 3.5, § 7.3, § 8.3]
- Lin, R.P. and Hudson, H.S.: 1971, 10–100 keV electron acceleration and emission from solar flares, *Solar Phys.*, v. 17, No. 2, 412–435. [§ 4.3]
- Lin, R.P., Dennis, B.R., Hurford, G.J., et al.: 2002, The Reuven Ramaty High-Energy Solar Spectroscopic Imager (RHESSI), *Solar Phys.*, v. 210, No. 1, 3–32. [§ 4.5]
- Lin, R.P., Krucker, S., Hurford, G.J., et al.: 2003, RHESSI observations of particle acceleration and energy release in an intense solar gamma-ray line flare, *Astrophys. J.*, v. 595, No. 2, L69–L76. [§ 4.5]
- Litvinenko, Y.E. and Somov, B.V.: 1991a, Solar flares and virial theorem, *Soviet Astronomy-AJ*, v. 35, No. 2, 183–188. [§ 19.1, § 19.2, § 19.5]
- Litvinenko, Y.E. and Somov, B.V.: 1991b, Nonthermal electrons in the thick-target reverse-current model for hard X-ray bremsstrahlung, *Solar Phys.*,

- v. 131, No. 2, 319–336. [§ 4.5]
- Litvinenko, Y.E. and Somov, B.V.: 1994, Electromagnetic expulsion force in cosmic plasma, *Astron. Astrophys.*, v. 287, No. 1, L37–L40. [§ 20.4]
- Litvinenko, Y.E. and Somov, B.V.: 2001, Aspects of the global MHD equilibria and filament eruptions in the solar corona, *Space Sci. Rev.*, v. 95, No. 1, 67–77. [§ 19.1, § 19.5]
- Liubarskii, G.Ya. and Polovin, R.V.: 1958, Simple magnetoacoustic waves, *Soviet Physics–JETP*, v. 8, No. 2, 351. [§ 16.2]
- Lovelace, R.V.E.: 1976, Dynamo model of double radio sources, *Nature*, v. 262, 649–652. [§ 20.1]
- Lundquist, S.: 1951, Magneto-hydrostatic fields, *Ark. Fys.*, v. 2, No. 35, 361–365. [§ 19.2]
- Macdonald, D.A., Thorne, K.S., Price, R.H., et al.: 1986, Astrophysical applications of black-hole electrodynamics, in *Black Holes: The Membrane Paradigm*, eds. K.S. Thorne, R.H. Price, and D.A. Macdonald, New Haven, London; Yale Univ. Press, p. 121–137. [§ 13.3]
- MacDonald, W.M., Rothenbluth, M.N., and Chuck, W.: 1957, Relaxation of a system of particles with Coulomb interactions, *Phys. Rev.*, v. 107, No. 2, 350–353. [§ 4.1]
- MacNeice, P., McWhirter, R.W.P., Spicer, D.S., et al.: 1984, A numerical model of a solar flare based on electron beam heating of the chromosphere, *Solar Phys.*, v. 90, No. 2, 357–353. [§ 8.3]
- Manmoto, T.: 2000, Advection-dominated accretion flow around a Kerr black hole, *Astrophys. J.*, v. 534, No. 2, 734–746. [§ 8.3, § 13.2]
- Markovskii, S.A. and Somov, B.V.: 1989, A model of magnetic reconnection in a current sheet with shock waves, *Fizika Solnechnoi Plazmy* (Physics of Solar Plasma), Moscow, Nauka, 456–472 (in Russian). [§ 14.2.2]
- Markovskii, S.A. and Somov, B.V.: 1996, MHD discontinuities in space plasmas: Interrelation between stability and structure, *Space Sci. Rev.*, v. 78, No. 3–4, 443–506. [§ 17.5]
- Marty, P. et Alemany, A.: 1983, Écoulement dû à des champs magnétique et électrique croisés autour d’un cylindre de conductivité quelconque, *Journal de Mécanique Théorique et Appliquée*, v. 2, No. 2, 227–243. [§ 19.4, § 20.3]
- McDonald, L., Harra-Murnion, L.K., and Culhane, J.L.: 1999, Nonthermal electron energy deposition in the chromosphere and the accompanying soft X-ray flare emission, *Solar Phys.*, v. 185, No. 2, 323–350. [§ 8.3]
- Michel, F.C.: 1991, *Theory of Neutron Star Magnetospheres*, Chicago, London; Chicago Univ. Press, p. 456. [§ 7.3, § 11.5.2, § 12.2]
- Mikhailovskii, A.B.: 1979, Nonlinear excitation of electromagnetic waves in a relativistic electron-positron plasma, *Soviet J. Plasma Phys.*, v. 6, No. 3, 336–340. [§ 7.3]
- Mikhailovskii, A.B., Onishchenko, O.G., and Tatarinov, E.G.: 1985, Alfvén solitons in a relativistic electron-positron plasma, *Plasma Physics and Controlled Fusion*, v. 27, No. 5, 539–556. [§ 7.3]

- Mirabel, I.F. and Rodriguez, L.F.: 1998, Microquasars in our Galaxy, *Nature*, v. 392, 673–676. [§ 20.1]
- Moffatt, H.K.: 1978, *Magnetic Field Generation in Electrically Conducting Fluids*, London, New York, Melbourne; Cambridge Univ. Press, p. 343. [§ 13.1]
- Moreau, R.: 1990, *Magnetohydrodynamics*, Dordrecht, Kluwer Academic Publ., p. 328. [§ 20.1]
- Morozov, A.I. and Solov'ev, L.S.: 1966a, The structure of magnetic fields, in: Leontovich M.A. (ed.), *Reviews of Plasma Physics*, New York, Consultants Bureau, v. 2, 1–101. [§ 19.3]
- Morozov, A.I. and Solov'ev, L.S.: 1966b, Motion of particles in electromagnetic fields, in: Leontovich M.A. (ed.), *Reviews of Plasma Physics*, New York, Consultants Bureau, v. 2, 201–297. [§ 5.2]
- Murata, H.: 1991, Magnetic field intensification and formation of field-aligned current in a non-uniform field, *J. Plasma Physics*, v. 46, No. 1, 29–48. [§ 11.1]
- Nakano, T.: 1998, Star formation in magnetic clouds, *Astrophys. J.*, v. 494, No. 2, 587–604. [§ 19.1]
- Narayan, R., Garcia, M.R., and McClintock, J.E.: 1997, Advection-dominated accretion and black hole horizons, *Astrophys. J.*, v. 478, No. 2, L79–L82. [§ 8.3]
- Negoro, H., Kitamoto, S., Takeuchi, M., et al.: 1995, Statistics of X-ray fluctuations from Cygnus X-1: Reservoirs in the disk? *Astrophys. J.*, v. 452, No. 1, L49–L52. [§ 13.2]
- Nishikawa, K.I., Frank, J., Christodoulou, D.M., et al.: 1999, 3D relativistic MHD simulations of extragalactic jets, in *Numerical Astrophysics*, eds S.M. Miyama et al., Dordrecht, Kluwer Academic Publ., p. 217–218. [§ 13.3]
- Northrop, T.G.: 1963, *The Adiabatic Motion of Charged Particles*, New York, John Wiley, Interscience. [§ 6.4]
- Novikov, I.D. and Frolov, V.P.: 1989, *Physics of Black Holes*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 341. [§ 11.5.2, § 12.2, § 13.3]
- Novikov, I.D. and Thorne, K.S.: 1973, in *Black Holes*, eds C.D. Dewitt and B. Dewitt, New York, Gordon and Breach, p. 345–354. [§ 8.3, § 13.2]
- Obertz, P.: 1973, Two-dimensional problem of the shape of the magnetosphere, *Geomagn. Aeron.*, v. 13, No. 5, 758–766. [§ 14.2]
- Oreshina, I.V. and Somov, B.V.: 1999, Conformal mapping for solving problems of space electrodynamics, *Bull. Russ. Acad. Sci., Physics*, v. 63, No. 8, 1209–1212. [§ 14.5]
- Ostriker, E.C.: 1999, Dynamical friction in a gaseous medium, *Astrophys. J.*, v. 513, No. 1, 252–258. [§ 8.5]
- Paesold, G. and Benz, A.O.: 1999, Electron firehose instability and acceleration of electrons in solar flares, *Astron. Astrophys.*, v. 351, 741–746. [§ 7.2]
- Palmer, P.L.: 1994, *Stability of Collisionless Stellar Systems*, Dordrecht, Kluwer Academic Publ., p. 349. [§ 9.6]

- Parker, E.N.: 1979, *Cosmic Magnetic Fields. Their Origin and Their Activity*, Oxford, Clarendon Press, p. 841. [§ 13.1, § 19.3, § 19.4, § 20.1]
- Parks, G.K.: 2004, *Physics of Space Plasmas, An Introduction, Second Edition*, Boulder, Oxford; Westview Press, p. 597. [Intr., § 14.5, § 18.1, § 18.2]
- Peacock, J.A.: 1999, *Cosmological Physics*, Cambridge, UK; Cambridge Univ. Press, p. 682. [§ 7.3, § 9.6]
- Persson, H.: 1963, Electric field along a magnetic line of force in a low-density plasma, *Phys. Fluids*, v. 6, No. 12, 1756–1759. [§ 8.1]
- Pfaffelmoser, K.: 1992, Global classic solutions of the Vlasov-Poisson system in three dimensions for general initial data, *J. Diff. Equations*, v. 95, 281–303. [§ 16.5]
- Planck, M.: 1917, *Sitz. der Preuss. Akad.*, 324. [§ 3.1]
- Polovin, R.V.: 1961, Shock waves in MHD, *Soviet Phys. Usp.*, v. 3, No. 5, 677–688. [§ 16.2, § 17.2]
- Polovin, R.V. and Demutskii, V.P.: 1990, *Fundamentals of Magnetohydrodynamics*, New York, Consultants Bureau. [§ 17.4]
- Polovin, R.V. and Liubarskii, G.Ya.: 1958, Impossibility of rarefaction shock waves in MHD, *Soviet Physics-JETP*, v. 8, No. 2, 351–352. [§ 16.2]
- Priest, E.R.: 1982, *Solar Magnetohydrodynamics*, Dordrecht, Boston, London; D. Reidel Publ. Co., p. 472. [§ 16.2, § 19.3]
- Punsly, B.: 2001, *Black Hole Gravito-hydro-magnetics*, New York, Berlin, Heidelberg, Tokyo; Springer-Verlag, p. 400. [§ 12.2.3]
- Ramos, J.I. and Winowich, N.S.: 1986, Magnetohydrodynamic channel flow study, *Phys. Fluids*, v. 29, No. 4, 992–997. [§ 20.2]
- Reid, I.N., Liebert, J., and Schmidt, G.D.: 2001, Discovery of a magnetic DZ white dwarf with Zeeman-split lines of heavy elements, *Astrophys. J.*, v. 550, No. 1, L61–L63. [§ 13.2]
- Rodrigues-Pacheco, J., Sequeiros, J., del Peral, L., et al.: 1998, Diffusive-shock-accelerated interplanetary ions during the solar cycle 21 maximum, *Solar Phys.*, v. 181, No. 1, 185–200. [§ 18.2]
- Roikhvarger, Z.B. and Syrovatskii, S.I.: 1974, Evolutionarity of MHD discontinuities with allowance for dissipative waves, *Soviet Physics-JETP*, v. 39, No. 4, 654–656. [§ 17.1, § 17.3]
- Rose, W.K.: 1998, *Advanced Stellar Astrophysics*, Cambridge, UK; Cambridge Univ. Press, p. 494. [§ 1.3, § 5.3, § 7.3, § 12.2, § 13.2]
- Rosenbluth, M. and Longmire, C.: 1957, Stability of plasmas confined by magnetic fields, *Ann. Phys.*, v. 1, No. 1, 120–140. [§ 19.3]
- Ruderman, M.: 1971, Matter in superstrong magnetic fields: The surface of a neutron star, *Phys. Rev. Lett.*, v. 27, No. 19, 1306–1308. [§ 5.3]
- Ruderman, M.A. and Sutherland, P.G.: 1975, Theory of pulsars: Polar gaps, sparks, and coherent radiation, *Astrophys. J.*, v. 196, No. 1, 51–72. [§ 7.3]
- Rüdiger, G. and von Rekowski, B.: 1998, Differential rotation and meridional flow for fast-rotating solar-type stars, *Astrophys. J.*, v. 494, No. 2, 691–699. [§ 13.1, § 20.1]

- Ruffolo, D.: 1999, Transport and acceleration of energetic particles near an oblique shock, *Astrophys. J.*, v. 515, No. 2, 787–800. [§ 18.2]
- Sarazin, C.L. and Kempner, J.C.: 2000, Nonthermal bremsstrahlung and hard X-ray emission from clusters of galaxies, *Astrophys. J.*, v. 533, No. 1, 73–83. [§ 8.3]
- Sarris, E.T. and Van Allen, J.A.: 1974, Effects of interplanetary shocks on energetic particles, *J. Geophys. Res.*, v. 79, No. 28, 4157–4173. [§ 18.3]
- Schabansky, V.P.: 1971, Some processes in the magnetosphere, *Space Sci. Rev.*, v. 12, No. 3, 299–418. [§ 11.1]
- Schlickeiser, R.: 2002, *Cosmic Ray Astrophysics*, New York, Berlin, Heidelberg, Tokyo; Springer-Verlag, p. 519. [§ 5.1]
- Schlüter, A.: 1951, Dynamic des Plasmas, *Zeitschrift für Naturforschung*, v. 6A, No. 2, 73–78. [§ 11.1]
- Schmidt, G.: 1979, *Physics of High Temperature Plasmas*, New York, London; Academic Press, p. 408. [§ 3.1]
- Schou, J., Antia, H.M., Basu, S., et al.: 1998, Helioseismic studies of differential rotation in the solar envelope by the solar oscillations investigation using the Michelson Doppler Imager, *Astrophys. J.*, v. 505, No. 1, 390–417. [§ 20.1]
- Schram, P.P.J.: 1991, *Kinetic Theory of Gases and Plasmas*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 426. [Intr., § 6.2.2]
- Schrijver, C.J. and Zwaan, C.: 1999, *Solar and Stellar Magnetic Activity*, Cambridge, UK; Cambridge Univ. Press, p. 400. [§ 20.1]
- Sedov, L.I.: 1973, *Mechanics of Continuous Medium*, Moscow, Nauka, v. 1, p. 536; v. 2, p. 584 (in Russian). [§ 13.1]
- Shafranov, V.D.: 1966, Plasma equilibrium in a magnetic field, in *Reviews of Plasma Physics*, ed. M.A. Leontovich, New York, Consultants Bureau, v. 2, 103–151. [§ 19.2, § 19.3]
- Shakura, N.I. and Sunyaev, R.A.: 1973, Black holes in binary systems, Observational appearance, *Astron. Astrophys.*, v. 24, No. 2, 337–355. [§ 8.3, § 13.2]
- Shercliff, A.J.: 1965, *A Textbook of Magnetohydrodynamics*, Oxford, London, New York; Pergamon Press, p. 265. [§ 13.1, § 16.2, § 17.4, § 20.2.2]
- Shkarofsky, I.P., Johnston, T.W., and Bachynski, M.P.: 1966, *The Particle Kinetics of Plasma*, Reading, Massachusetts; Addison-Wesley Publ., p. 518. [§ 1.1, § 9.3, § 9.5, § 11.5, § 12.2.2]
- Shoub, E.C.: 1983, Invalidity of local thermodynamic equilibrium for electrons in solar transition region, *Astrophys. J.*, v. 266, No. 1, 339–369. [§ 8.4]
- Shoub, E.C.: 1987, Failure of the Fokker-Planck approximation to the Boltzmann integral for $(1/r)$ potentials, *Phys. Fluids.*, v. 30, No. 5, 1340–1352. [§ 3.1, § 3.5]
- Shu, F.H.: 1992, *The Physics of Astrophysics, v. 2, Gas Dynamics*, Mill Valley, California; Univ. Science Books, p. 476. [§ 6.2.2, § 19.3]
- Silin, V.P.: 1971, *Intoduction to the Kinetic Theory of Gases*, Moscow, Nauka, p. 332 (in Russian). [§ 3.1, § 3.5, § 6.2.2]

- Simon, A.L.: 1959, *An Introduction to Thermonuclear Research*, London, Pergamon Press, p. 182. [Intr.]
- Sirotina, E.P. and Syrovatskii, S.I.: 1960, Structure of low intensity shock waves in MHD, *Soviet Physics-JETP*, v. 12, No. 3, 521–526. [§ 16.4, § 17.3]
- Sivukhin, D.V.: 1965, Motion of charged particles in electromagnetic fields in the drift approximation, in *Reviews of Plasma Physics*, ed. M.A. Leontovich, New York, Consultants Bureau, v. 1, 1–104. [§ 5.2]
- Sivukhin, D.V.: 1966, Coulomb collisions in a fully ionized plasma, in *Reviews of Plasma Physics*, ed. M.A. Leontovich, New York, Consultants Bureau, v. 4, 93–341. [§ 8.3, § 8.4]
- Sivukhin, D.V.: 1996, *A Course of General Physics. Electricity*, 3rd Edition, Moscow, Nauka, (in Russian). [§ 11.4.2, § 19.2]
- Smirnov, B.M.: 1981, *Physics of Weakly Ionized Gases: Problems and Solutions*, Moscow, Mir Publ., p. 432. [§ 3.5]
- Smirnov, V.I.: 1965, *A Course of Higher Mathematics*, v. 2, Oxford, New York; Pergamon Press. [§ 1.1, § 12.3]
- Somov, B.V.: 1981, Fast reconnection and transient phenomena with particle acceleration in the solar corona, *Bull. Acad. Sci. USSR, Phys. Ser.*, v. 45, No. 4, 114–116. [§ 8.3.2]
- Somov, B.V.: 1982, Accumulation and release of flare energy, in *Proc. 12th Leningrad Seminar on Space Physics: Complex Study of the Sun*, Leningrad, LIYaF, p. 6–49 (in Russian). [§ 4.1, § 4.4]
- Somov, B.V.: 1986, Non-neutral current sheets and solar flare energetics, *Astron. Astrophys.*, v. 163, No. 1, 210–218. [§ 8.3]
- Somov, B.V.: 1992, *Physical Processes in Solar Flares*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 248. [§ 8.3, § 8.4, § 19.5]
- Somov, B.V.: 1994a, *Fundamentals of Cosmic Electrodynamics*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 364. [§ 14.2]
- Somov, B.V.: 1994b, Features of mass supply and flows related with reconnection in the solar corona, *Space Sci. Rev.*, v. 70, No. 1, 161–166. [§ 19.4, § 20.4]
- Somov, B.V. and Syrovatskii, S.I.: 1972a, Plasma motion in an increasing strong dipolar field, *Soviet Phys.-JETP*, v. 34, No. 2, 332–335. [§ 14.4]
- Somov, B.V. and Syrovatskii, S.I.: 1972b, Appearance of a current sheet in a plasma moving in the field of a two-dimensional magnetic dipole, *Soviet Phys.-JETP*, v. 34, No. 5, 992–997. [§ 14.2]
- Somov, B.V. and Syrovatskii, S.I.: 1976a, Physical processes in the solar atmosphere associated with flares, *Soviet Physics Usp.*, v. 19, No. 10, 813–835. [§ 8.3]
- Somov, B.V. and Syrovatskii, S.I.: 1976b, Hydrodynamic plasma flows in a strong magnetic field, in *Neutral Current Sheets in Plasma*, Proc. P.N. Lebedev Phys. Inst., v. 74, ed. N.G. Basov, New York and London, Consultants Bureau, p. 13–71. [§ 13.1, § 14.1, § 14.2, § 14.4]

- Somov, B.V. and Tindo, I.P.: 1978, Polarization of hard X-rays from solar flares, *Cosmic Research*, v. 16, No. 5, 555-564. [§ 4.5]
- Somov, B.V. and Titov, V.S.: 1983, Magnetic reconnection as a mechanism for heating the coronal loops, *Soviet Astronomy Letters*, v. 9, No. 1, 26-28. [§ 8.3]
- Somov, B.V., Syrovatskii, S.I., and Spektor, A.R.: 1981, Hydrodynamic response of the solar chromosphere to elementary flare burst. 1. Heating by accelerated electrons, *Solar Phys.*, v. 73, No. 1, 145-155. [§ 8.3]
- Spicer, D.S. and Emslie, A.G.: 1988, A new quasi-thermal trap model for solar hard X-ray bursts: An electrostatic trap model, *Astrophys. J.*, v. 330, No. 2, 997-1007. [§ 8.1]
- Spitzer, L.: 1940, The stability of isolated clusters, *Mon. Not. Royal Astron. Soc.*, v. 100, No. 5, 396-413. [§ 8.3]
- Spitzer, L.: 1962, *Physics of Fully Ionized Gases*, New York, Wiley Interscience, p. 170. [§ 8.3, § 8.4, § 9.5]
- Stewart, R.W. and Grant, H.L.: 1969, Determination of the rate of dissipation of turbulent energy near the sea surface in the presence of waves, *J. Geophys. Res.*, v. 67, 3177-3184. [§ 7.2.2]
- Stix, T.H.: 1992, *Waves in Plasmas*, American Inst. of Physics. [§ 10.4]
- Störmer, C.: 1955, *The Polar Aurora*, Oxford, Clarendon Press. [§ 6.4]
- Strittmatter, P.A.: 1966, Gravitational collapse in the presence of a magnetic field, *Monthly Not. Royal Astron. Soc.*, v. 132, No. 3, 359-378. [§ 19.1]
- Strong, K.T., Saba, J.L.R., Haisch, B.M., et al. (eds): 1999, *The Many Faces of the Sun*, New York, Berlin, Heidelberg, Tokyo; Springer, p. 610. [§ 4.3]
- Subramanian, P., Becker, P.A., and Kazanas, D.: 1999, Formation of relativistic outflows in shearing black hole accretion coronae, *Astrophys. J.*, v. 523, No. 1, 203-222. [§ 13.3]
- Suh, I.S. and Mathews, G.J.: 2001, Cold ideal equation of state for strongly magnetized neutron star matter: Effects on muon production and pion condensation, *Astrophys. J.*, v. 546, No. 3, 1126-1136. [§ 19.1]
- Sutton, G.W. and Sherman, A.: 1965, *Engineering Magnetohydrodynamics*, New York, McGraw-Hill Book Co., p. 548. [§ 13.1, § 20.2]
- Syrovatskii, S.I.: 1953, On the stability of tangential discontinuities in MHD medium, *Zhur. Exper. Teor. Fiz.*, v. 24, No. 6, 622-630 (in Russian). [§ 16.2]
- Syrovatskii, S.I.: 1954, Instability of tangential discontinuities in a compressive medium, *Zhur. Exper. Teor. Fiz.*, v. 27, No. 1, 121-123 (in Russian). [§ 16.2]
- Syrovatskii, S.I.: 1956, Some properties of discontinuity surfaces in MHD, *Proc. P.N. Lebedev Phys. Inst.*, v. 8, 13-64 (in Russian). [§ 16.2, § 16.3, § 20.1]
- Syrovatskii, S.I.: 1957, Magnetohydrodynamics, *Uspehi Fiz. Nauk*, v. 62, No. 3, 247-303 (in Russian). [§ 12.2, § 16.2, § 19.1, § 20.1]
- Syrovatskii, S.I.: 1959, The stability of shock waves in MHD, *Soviet Physics-JETP*, v. 8, No. 6, 1024-1028. [§ 17.1]

- Syrovatkii, S.I.: 1971, Formation of current sheets in a plasma with a frozen-in strong field, *Soviet Physics-JETP*, v. 33, No. 5, 933–940. [§ 14.2.2]
- Syrovatkii, S.I. and Chesalin, L.S.: 1963, Electromagnetic generation of conductive fluid flows near bodies and expulsive force, in *Questions of Magnetohydrodynamics*, Riga, Zinatne, p. 17–22 (in Russian). [§ 19.4, § 20.3]
- Syrovatkii, S.I. and Shmeleva, O.P.: 1972, Heating of plasma by high-energy electrons, and the non-thermal X-ray emission in solar flares, *Soviet Astronomy-AJ*, v. 16, No. 2, 273–283. [§ 4.3]
- Syrovatkii, S.I. and Somov, B.V.: 1980, Physical driving forces and models of coronal responses, in *Solar and Interplanetary Dynamics*, eds M. Dryer and E. Tandberg-Hanssen, IAU Symp. **91**, Dordrecht, Reidel, p. 425–441. [§ 14.2]
- Takahara, F. and Kusunose, M.: 1985, Electron-positron pair production in a hot accretion plasma around a massive black hole, *Progr. Theor. Phys.*, v. 73, No. 6, 1390–1400. [§ 7.3]
- Takizawa, M.: 1998, A two-temperature model of the intracluster medium, *Astrophys. J.*, v. 509, No. 2, 579–584. [§ 8.3]
- Tamm, I.E.: 1989, *Basic Theory of Electricity*, 10th edition, Moscow, Nauka, p. 504 (in Russian). [§ 19.3]
- Tandberg-Hanssen, E.: 1995, *The Nature of Solar Prominences*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 308. [§ 19.3, § 20.4]
- Tidman, D.A. and Krall, N.A.: 1971, *Shock Waves in Collisionless Plasma*, New York, London, Sydney, Toronto; Wiley-Interscience, p. 175. [§ 16.4]
- Titov, V.S. and Priest, E.R.: 1993, The collapse of an X-type neutral point to form a reconnecting current sheet. *Geophys. and Astrophys. Fluid Dynamics*, v. 72, 249–276. [§ 14.2]
- Toptyghin, I.N.: 1980, Acceleration of particles by shocks in a cosmic plasma, *Space Sci. Rev.*, v. 26, No. 1, 157–213. [§ 18.3]
- Treumann, R.A. and Baumjohann, W.: 1997, *Advanced Space Plasma Physics*, London, Imperial College Press, p. 381. [§ 7.1]
- Trubnikov, B.A.: 1965, Particle interactions in a fully ionized plasma, in *Reviews of Plasma Physics*, ed. M.A. Leontovich, New York, Consultants Bureau, v. 1, 105–204. [§ 8.4]
- Tverskoy B.A.: 1967, Contribution to the theory of Fermi statistical acceleration, *Soviet Phys. JETP.*, v. 25, No. 2, 317–325. [§ 7.2]
- Tverskoy B.A.: 1968, Theory of turbulent acceleration of charged particles in a plasma, *Soviet Phys. JETP.*, v. 26, No. 4, 821–828. [§ 7.2]
- Tverskoy B.A.: 1969, Main mechanisms in the formation of the Earth's radiation belts, *Rev. Geophys.*, v. 7, No. 1, 219–231. [§ 6.4]
- UeNo, S.: 1998, Comparison between statistical features of X-ray fluctuations from the solar corona and accretion disks, in *Observational Plasma Astrophysics: Five Years of Yohkoh and Beyond*, eds T. Watanabe, T. Kosugi, and A.C. Sterling, Dordrecht, Kluwer Academic Publ., p. 45–50. [§ 13.2]
- van de Hulst, H.C.: 1951, Interstellar polarization and MHD waves, in *Problems of Cosmical Aerodynamics*, eds J.M. Burgers and H.C. van de Hulst,

- p. 45–57. [§ 15.2, § 15.3]
- van den Oord, G.H.J.: 1990, The electrodynamics of beam/return current systems in the solar corona, *Astron. Astrophys.*, v. 234, No. 2, 496–518. [§ 4.5]
- Vink, J., Laming, J.M., Gu, M.F., et al.: 2003, The slow temperature equilibration behind the shock front of SN 1006, *Astrophys. J.*, v. 587, No. 1, L31–L34. [§ 16.4]
- Vladimirov, V.S.: 1971, *Equations of Mathematical Physics*, New York, M. Dekker, p. 418. [§ 1.1.5, § 1.2.2, § 13.1]
- Vlasov, A.A.: 1938, On the oscillation properties of an electron gas, *Zhur. Eksp. Teor. Fiz.*, v. 8, No. 1, 29–33 (in Russian). English translation: 1968, The vibrational properties of an electron gas, *Soviet Physics Uspekhi*, v. 10, No. 4, 721–733; see also *Soviet Physics Uspekhi*, v. 19, No. 6, 545–546 [§ 3.1, § 10.2.2]
- Vlasov, A.A.: 1945, On the kinetic theory of an assembly of particles with collective interactions, *Soviet J. Phys.*, v. 9, No. 1, 25–28. [§ 3.1]
- Volkov, T.F.: 1966, Hydrodynamic description of a collisionless plasma, in *Reviews of Plasma Physics*, ed. M.A. Leontovich, New York, Consultant Bureau, v. 4, 1–21. [§ 11.5.1, § 16.4]
- Walt, M.: 1994, *Introduction to Geomagnetically Trapped Radiation*, Cambridge, UK; Cambridge Univ. Press, p. 188. [§ 6.4]
- Webb, G.M.: 1986, Similarity considerations and conservation laws for magnetostatic atmospheres, *Solar Phys.*, v. 106, No. 2, 287–313. [§ 19.5]
- Webb, G.M., Zank, G.P., Ko, C.M., et al.: 1995, Multi-dimensional Green's functions and the statistics of diffusive shock acceleration, *Astrophys. J.*, v. 453, No. 1, 178–189. [§ 18.2]
- Wentzel, D.G.: 1963, Fermi acceleration of charged particles, *Astrophys. J.*, v. 137, No. 1, 135–146. [§ 18.3]
- Wentzel, D.G.: 1964, Motion across magnetic discontinuities and Fermi acceleration of charged particles, *Astrophys. J.*, v. 140, No. 3, 1013–1024. [§ 6.2.4, § 18.3]
- Wiita, P.J.: 1999, Accretion disks around black holes, in *Black Holes, Gravitational Radiation and the Universe*, eds B.R. Iyer and B. Bhawal, Dordrecht, Boston, London; Kluwer Academic Publ., p. 249–263. [§ 8.3]
- Woltjer, L.: 1958, A theorem on force-free magnetic fields, *Proc. Nat. Acad. Sci. USA*, v. 44, No. 6, 489–491. [§ 19.6]
- Yvon, J.: 1935, *La Theorie des Fluids et l'Equation d'Etat*, Paris, Hermann et Cie. [§ 2.4]
- Zank, G.P.: 1991, Weyl's theorem for MHD, *J. Plasma Phys.*, v. 46, No. 1, 11–14. [§ 16.2]
- Zel'dovich, Ya.B. and Novikov, I.D.: 1971, *Relativistic Astrophysics. Vol. 1, Stars and Relativity*, Chicago, Univ. of Chicago Press. [§ 12.2, § 19.3]
- Zel'dovich, Ya.B. and Raizer, Yu.P.: 1966, *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*, New York, San Francisco, London; Academic Press, v. 1, p. 464; v. 2, p. 452. [§ 8.3, § 16.1, § 16.4]

- Zel'dovich, Ya.B. and Raizer, Yu.P.: 2002, *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*, eds W.D. Hayes and R.F. Probstein, Mineola, Dover. [§ 8.3, § 16.1, § 16.4]
- Zel'dovich, Ya.B., Ruzmaikin, A.A., and Sokolov, D.D.: 1983, *Magnetic Fields in Astrophysics*, New York, Gordon and Breach. [§ 13.1]
- Zheleznyakov, V.V.: 1996, *Radiation in Astrophysical Plasmas*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 462. [§ 7.1, § 7.4, § 10.4]
- Zhou, Y. and Matthaeus, W.H.: 1990, Models of inertial range spectra of MHD turbulence, *J. Geophys. Res.*, v. 95, No. A9, 14881–14892. [§ 7.2]

Index

- abundance
 - elements, 96
- acceleration
 - Alfvén pumping, 124
 - by electric field, 196
 - by magnetic inhomogeneities, 109, 328
 - by MHD turbulence, 110
 - by shock waves, 110, 327
 - diffusive, 328
 - drift, 332
 - by waves, 122
 - electrons, 97
 - Fermi, 109, 123, 237
 - guiding center, 93
 - in solar flares, 60, 97, 110
 - ions, 98
 - particle, 7, 13, 109, 147
 - protons, 110, 337
 - stochastic, 109, 123
- accretion
 - magnetic, 231
- accretion disk, 127, 150, 170, 229, 379
 - black hole, 231, 234, 370
 - white dwarf, 231
- active galaxy, 127, 150, 232, 237, 369
- active region, 353
- adiabatic cooling, 109
- adiabatic invariant, 103
 - first *or* transversal, 105
 - second *or* longitudinal, 108
 - third *or* flux invariant, 111
- adiabatic process, 277
- adiabatic theory
 - accuracy, 112
- advection, 150, 170, 232
- advective derivative, 173
- Alfvén, 1, 237, 268, 371
- Alfvén discontinuity, 296, 371
 - propagation order, 314
- Alfvén pumping, 124
- Alfvén soliton, 128
- Alfvén wave, 128, 267, 296, 312, 371
- algebra of Lie, 175
- Ap star, 349
- approximation
 - binary collisions, 35, 133
 - CGL, 128, 201
 - cold ions, 135, 141, 142, 184
 - collisionless, 136
 - diffusion, 126
 - hydrodynamic, 68, 190
 - isotropic conductivity, 200
 - kinetic, 69, 191
 - large mag. Reynolds number, 223, 386
 - magnetostatic, 227, 353
 - non-relativistic, 83, 105, 212
 - small displacement, 228, 254
 - small mag. Reynolds number, 223, 374, 379
 - stationary, 228, 281, 367
 - strong magnetic field, 197, 226, 270
 - strong-field-cold-plasma, 228, 243, 251, 252
 - two-dimensional, 245
 - two-fluid, 194
 - two-temperature, 237
 - weak Coulomb interaction, 139
 - weak magnetic field, 197, 225, 230

- atmosphere
 - solar, 41, 136, 138, 141, 228, 272, 315, 351, 374
- Aurora, 119
- averaged force, 29, 42, 163
- BBGKY hierarchy, 33
- betatron acceleration, 124
- binary interaction, 27, 133
- binary stars, 150, 229
- black hole, 127, 150, 170, 202, 370
 - supermassive, 161, 232
- Boltzmann integral, 40, 50
- Boltzmann law, 139
- Bondi accretion, 232
- boundary conditions, 13, 297
 - ideal MHD, 281
 - isolated groups, 279, 308
 - linearized, 307
- boundary layer, 376
- bremsstrahlung, 63, 138, 144, 149
- bump-on-tail instability, 119
- catenary, 80
- centrifugal force, 94
- Chandra, 233
- charge neutrality, 141, 201
- Cherenkov, 129
- Cherenkov condition, 129, 275
- Cherenkov effect, 119
- chromospheric evaporation, 110
- Clebsch variables, 258
- cluster of galaxies, 148
- collapse
 - gravitational, 43, 348
 - star, 258, 348
- collapsing magnetic trap, 98, 110, 136, 338
- collective phenomena, 45, 142
- collision
 - characteristic time, 137, 169, 176
 - close, 41, 134, 158
 - Coulomb, 14, 38, 55, 133
 - cross-section, 134
 - distant, 39, 134, 158
 - frequency, 138
 - mean free path, 135
- collisional integral, 8, 26, 30, 46, 163
 - Boltzmann, 50
 - Landau, 38, 41, 46, 56
- collisional time
 - between electrons, 142, 160
 - between electrons and ions, 143
 - between ions, 142, 237
- collisionless plasma, 115, 298
- complex potential, 250
- conditions
 - boundary, 13, 281, 297
 - isolated groups, 308
 - linearized, 307
 - electrodynamic continuity, 282
 - evolutionarity, 307, 313
 - initial, 13, 244, 252
- conductive current, 202, 211
- conductivity
 - anisotropic, 203
 - electric, 193
 - Hall, 196
 - isotropic, 197, 200, 210
 - parallel, 203
 - perpendicular, 196
 - thermal, 149, 214
- conform mapping, 250, 259
- conservation law
 - energy, 17, 208, 279, 282
 - magnetic flux, 216, 220
 - mass, 166, 279, 282
 - momentum, 206, 215, 279, 282
 - particles, 4
- contact discontinuity, 284
 - evolutionarity, 313
- continuity equation, 244
 - electric charge, 12
 - for particles of kind k , 166
 - for plasma, 206
 - in phase space, 4
 - Lagrangian form, 251
- convective current, 202, 211
- cooling
 - adiabatic, 109

- by heat flux, 146
 - radiative, 144
- coordinates
 - doubly Lagrangian, 256
 - generalized, 16, 103
 - Lagrangian, 254
 - polarized, 120
- cork ratio, 107
- coronal heating, 273
- coronal mass ejection, 148, 213, 359
- coronal transient, 213
- correlation function
 - binary, 28, 31
 - triple, 33, 43
- corrugational instability, 325
- cosmic rays, 82, 110, 237, 330, 332
- Coulomb collision, 13, 22, 55, 133
- Coulomb force, 30
- Coulomb logarithm, 38, 138, 141, 159
- current
 - conductive, 202, 211
 - convective, 202, 211
 - direct, 41, 69
 - displacement, 211
 - reverse, 41, 68, 158
- current layer
 - high-temperature turbulent, 147
- curvature
 - magnetic field line, 93, 239
- cyclotron *or* gyrofrequency, 97
- damping
 - Alfvén wave, 271
 - collisional, 142
 - Landau, 39, 118
- de Broglie wavelength, 98
- Debye radius, 45, 139, 157, 186
- density
 - charge, 202, 206
 - in MHD, 212
 - current in MHD, 212
 - energy flux, 17, 214, 220
 - friction, 214
 - heat, 214
 - magnetic field energy, 226, 240, 286
 - mass, 164
 - momentum flux, 213
 - number, 164
 - particle flux in phase space, 4
 - plasma, 255
 - probability distribution, 24
 - spectral, 123
- description
 - exact, 10
 - kinetic *or* microscopic, 14, 163
 - macroscopic, 14, 163
 - statistical, 10
- diamagnetic effect, 90
- differential rotation, 232, 371
- diffusion
 - pitch angle, 121
 - quasi-linear, 192
 - turbulent, 226
- diffusivity
 - magnetic, 217
- dimensionless parameters, 86, 225
- dipole moment, 253
- direct current, 41, 69
- discontinuity
 - Alfvén *or* rotational, 296
 - evolutionarity, 313
 - boundary conditions, 297
 - hydrodynamics, 278
 - ideal MHD, 281
 - linearized, 307
 - classification, 281
 - contact, 284, 318
 - evolutionary, 305
 - non-evolutionary, 305
 - shock wave, 277, 280, 287
 - small perturbations, 305
 - switch-off wave
 - evolutionarity, 312
 - switch-on shock
 - evolutionarity, 313
 - tangential, 270, 280, 285, 318, 326, 368
 - transitional, 297

- weak, 318
- discontinuous flow, 263
- discontinuous solutions
 - continuous transitions, 296, 315
- dispersion equation, 265, 325
- displacement current, 211
- dissipation
 - Joule, 147, 199, 218
- dissipative wave, 312
- distribution function, 3
 - averaged, 20, 27
 - bump-on-tail, 107, 119
 - exact, 9, 19, 26
 - Maxwellian, 176
 - non-equilibrium, 107
- Dreicer field, 156, 160
- drift
 - centrifugal, 93, 95
 - curvature-dependent, 95
 - electric, 84, 92
 - gradient, 92
 - gravitational, 86, 92
 - inertial, 93
 - non-magnetic force, 84
- drift shell, 111
- dynamic friction, 40, 151
 - gravitational, 160
- dynamical trajectory, 22
- dynamo
 - gravitomagnetic, 236
 - magnetic, 225, 232, 349
 - photospheric, 378
 - turbulent, 225
- Earth
 - magnetic field, 82, 111, 112
- electric conductivity
 - anisotropic, 196
 - isotropic, 193
- electric drift, 84, 92
- electric field, 11
 - Dreicer, 156
 - in MHD, 212
 - in moving plasma, 210
 - reverse current, 158
- electric neutrality, 43, 194, 201
- electric resistivity, 217
- electromagnetic force, 207
- energy conservation law, 169, 208, 279
- energy flux density, 17, 214, 220, 240
- enthalpy
 - specific, 171, 214, 300
- entropy, 214
- entropy wave, 266, 308, 312
- equation
 - biharmonic, 383
 - continuity, 4, 12, 166, 184, 206, 244
 - correlation function, 30, 32
 - diffusion, 40
 - diffusion-convection, 328
 - dispersion, 265, 325
 - Fokker-Planck, 40, 46
 - freezing-in, 220, 244
 - guiding center motion, 89, 91
 - heat transfer, 215
 - kinetic, 26, 30, 163
 - Langevin, 48
 - linear oscillator, 185
 - Liouville, 6, 19
 - motion, 79, 184, 212, 215, 249
 - Poisson, 51, 139
 - state, 214
 - ideal gas, 171, 176
 - linearized, 264
 - Vlasov, 37, 115
- equations
 - autonomous, 321
 - Einstein, 215, 241
 - Hamilton, 15
 - ideal MHD, 219, 224, 281
 - linearized, 264
 - magnetic field line, 247
 - Maxwell, 11, 37, 116, 211
 - MHD, 209
 - Newton, 12
 - particle motion, 12
 - transfer, 123, 164, 173, 219
- equilibrium
 - MHD, 343

- thermodynamic, 42, 139, 171
- Euler potentials, 258
- evolutionarity
 - Alfvén discontinuity, 313
 - conditions, 307, 313
 - consequences, 313
 - contact discontinuity, 313
 - continuous transitions, 315
 - definitions, 305
 - fast shock wave, 312
 - slow shock wave, 312
 - switch-off shock, 312
 - switch-on shock, 312
 - tangential discontinuity, 313
- exact distribution function, 9, 19, 26
- expulsion force, 362, 379
- Fermi acceleration, 109, 123, 124, 237
- field
 - constant homogeneous, 80
 - slowly changing weakly inhomogeneous, 87, 104
 - weakly inhomogeneous, 87
- fire-hose instability, 128
- flare
 - accretion disk, 233
 - solar, 60, 63, 97, 101, 106, 110, 119, 136, 138, 144, 158, 188, 191, 234, 314, 359
- fluid particle, 249, 253
- Fokker-Planck equation, 40, 46
- force
 - Archimedean, 359, 362, 379
 - averaged, 29, 42
 - binary, 27
 - centrifugal, 94
 - collisional drag, 151, 193
 - Coulomb, 30
 - electric
 - in MHD, 212
 - electromagnetic, 14, 207
 - expulsion, 379
 - friction, 7, 74, 172, 184, 208
 - gravitational, 7, 14, 30, 46, 160, 225, 241
 - gravitomagnetic, 234, 241
 - inertia, 227
 - Lorentz, 7, 30, 167, 359
 - magnetic, 81, 212
 - magnetic σ -dependent, 361, 379
 - magnetic buoyancy, 361
 - mean, 25, 46, 167
 - mean collisional, 168
 - non-magnetic, 80, 83, 227
 - statistically averaged, 163, 167
 - viscous, 172, 212, 385
- force-free field, 226, 244, 350
 - helicity, 363
 - linear, 363
- fractionation
 - elements, 96, 184
- freezing-in equation, 244
- frequency
 - collision, 138, 142, 169
 - electron plasma, 141, 185
 - gyrofrequency *or* cyclotron, 81, 97
 - ion plasma, 188
- friction force, 7, 74, 160, 172, 183, 193, 208
- function
 - correlation, 28
 - delta, 11
 - distribution, 3
 - heat, 171
 - Maxwellian, 42, 171
 - stream, 256
- galaxy
 - active, 232
 - elliptical, 232
- gas
 - ideal, 171, 176
- general relativity, 215
- geomagnetic storm, 113
- geomagnetic tail, 358
- Giovanelli, 156
- gradient drift, 92
- gravitational drag, 161
- gravitational drift, 86, 92

- gravitational energy, 346
- gravitational force, 7, 14, 30, 46, 160, 178, 225, 303
- gravitational pressure, 348
- gravitational system, 15, 43, 46, 137, 177
- group velocity, 265
- guiding center, 87, 111, 121
- guiding center acceleration, 93
- guiding center motion
 - flux invariant, 112
- guiding center spiral, 92
- gyromotion, 87
- gyroradius *or* Larmor radius, 82
- gyroresonance, 121

- Hall current, 196, 204
- Hamilton equations, 15
- Hamiltonian
 - usual, 15
- hard X-ray bremsstrahlung, 63, 138
- Hartmann number, 376
- heat flux density, 172
- heat function, 171
- heating
 - by electron beam, 144
 - chromospheric, 107
 - coronal, 273
 - Joule, 215
 - viscous, 215
- helioseismology, 373
- horizon
 - black hole, 150, 232
- hydrodynamic velocity, 205

- ideal gas, 171, 176
- ideal MHD, 219
- impact parameter, 134
- inertial drift, 93
- initial conditions, 13, 244, 252
- injection energy, 123
- injection spectrum, 61
- instability
 - bump-on-tail, 119
 - corrugational, 325
 - fire-hose, 128, 131
 - Jean, 178
 - kinetic, 107, 298
 - magnetorotational, 230
 - shear, 229
 - two-stream, 119
- integral
 - collisional, 8, 26, 30, 46, 163
 - motion, 112, 249, 253
- interaction
 - binary, 27
 - Coulomb, 41, 133
 - weak, 36, 139
 - electromagnetic, 13
 - particles, 5
 - wave-particle, 13, 15, 115
- interaction parameter, 28, 36
- interstellar medium, 232
- intracluster medium, 148
- invariant
 - adiabatic, 103
 - motion, 15
- ion-acoustic wave, 118, 188
- ionosphere, 190
- Irishow theorem, 352
- isorotation, 372

- Jean's instability, 178
- Jeans, 137
- Jeans theorem, 15, 117
- jet
 - astrophysical, 369
 - bi-directional, 148, 369
 - disk corona, 236
 - non-relativistic, 368
 - relativistic, 127, 207, 234, 370
- Joule dissipation, 147
- Joule heating, 149, 215

- kinematic problems, 225
- kinetic energy, 345
- kinetic equation, 26, 30, 163
- Kolmogorov, 124
- Kolmogorov spectrum, 125

- Lagrangian coordinates, 254

- Lagrangian lines, 249
- Lagrangian variables, 249, 253
- Landau
 - collisional integral, 38, 46, 56
 - gravitational analog, 53
- Landau damping, 39, 118, 191
 - nonlinear, 120
- Landau resonance, 39, 117
- Langevin equation, 48
- Langmuir wave, 118, 141, 184, 185, 202
- Larmor radius, 88, 97
- law
 - T to the 3/2 power, 137
 - Boltzmann, 139
 - conservation, 169, 206, 220, 282
 - Ohm's, 14, 193
- layer
 - boundary, 376
 - reconnecting, 390
- Lichnerowicz, 215
- Lie algebra, 175
- Liouville equation, 6, 19
- Liouville operator, 6, 116, 128
- Liouville theorem, 6
- liquid contour, 217
- loop
 - flaring, 106, 110
- Lorentz factor, 79, 123, 129
- Lorentz force, 7, 30, 86, 167, 370
- loss cone
 - anomalous diffusion, 107
 - magnetic trap, 107
- macroparticle method, 47
- magnetar, 99, 259, 349
- magnetic collapse, 251, 261
- magnetic diffusivity, 213, 217, 379
- magnetic dynamo, 225, 232
- magnetic energy, 346, 363
- magnetic field
 - force free, 226, 244, 350
 - helical, 351
 - interplanetary, 338
 - limiting line, 246
 - longitudinal, 246
 - plane dipole, 253
 - potential *or* current free, 227
 - shear, 351
 - superstrong, 99
 - toroidal, 372
 - transversal, 374
 - ultrastrong, 99, 259, 349
 - zeroth point *or* line, 246
- magnetic field line
 - equations, 247
 - meaning, 220
 - separator, 246
- magnetic flux, 248
- magnetic flux conservation, 216, 220
- magnetic flux tube
 - coronal, 106
 - specific volume, 356
- magnetic force, 81, 212
- magnetic helicity
 - global, 363
- magnetic mirror, 106
- magnetic moment, 90, 102, 105, 257
- magnetic pressure, 227, 285, 291, 351, 368
 - perturbation, 269
- magnetic reconnection, 14, 171, 234, 246, 251
 - collisionless, 14
- magnetic Reynolds number, 218
- magnetic separator, 386
- magnetic sound, 270
- magnetic stresses, 229
- magnetic surface, 111, 354
- magnetic tension, 227, 239, 267, 351, 371
- magnetic trap, 98, 106, 136, 338
- magnetoacoustic wave, 312
 - fast, 288, 292
 - slow, 292
- magnetohydrodynamics, 14, 200, 209, 212
 - relativistic, 215
- magnetosphere
 - black hole, 127, 202

- Earth, 82, 228
- Jovian, 101
- pulsar, 127, 202
- white dwarf, 231
- Maxwell equations, 11, 37, 116, 211
- Maxwellian function, 42, 171, 176
- Maxwellian stress tensor, 207, 344
- mean collisional force, 168
- mean field, 226
- mean force, 25, 46, 167
- mean free path, 135, 157, 176
- mean kinetic energy, 170
- mean momentum, 164
- mean thermal velocity, 97, 136
- mean velocity, 164
- MHD assumptions, 211
- MHD pump, 378
- MHD turbulence, 110, 124, 126
- microquasar, 370
- minimum current corona, 364
- mixing mechanism, 22
- moment
 - inertia, 345
 - magnetic, 90, 102, 105, 257
 - of distribution function, 164
 - viscous force, 385
- momentum
 - angular, 229, 373
 - conservation, 279
 - electromagnetic field, 213
 - generalized, 16, 103
 - longitudinal, 127
 - mean, 164
 - plasma stream, 213
 - transversal, 105, 127
- momentum flux density tensor, 165, 207, 213, 220
- motion
 - guiding center, 89, 112
 - spiral, 84
- neutron star, 99, 150, 259, 349
- Newton equations, 12
- Ohm's law
 - generalized, 14, 196
 - in MHD, 200, 210
 - usual, 14, 69, 193
- operator
 - Liouville, 6, 116, 128
- parameter
 - m/e , 87
 - interaction, 28, 36
 - plasma, 45
- particle
 - accelerated, 41, 109
 - field, 38, 135
 - fluid, 249
 - precipitating, 107
 - test, 135
 - trapped, 107, 113
- particle flux density, 4
- particle interaction, 5
- particle simulation, 14
- phase space, 3, 19
- phase trajectory, 6
- phase velocity, 265
- phase velocity diagram, 269, 296
- pinch effect, 246
- pitch-angle, 82, 107, 122
- plasma, 43
 - anisotropic, 172
 - charge-separated, 202
 - collisional, 38, 115
 - collisionless, 38, 115, 127, 201
 - dusty, 14
 - electron-positron, 127
 - fully-ionized, 38, 55, 183
 - self-gravitational, 14
 - strongly-coupled, 36
 - superhot, 98
 - three-component, 194
 - two-temperature, 143
 - weakly-coupled, 36
 - weakly-ionized, 14, 378
- plasma frequency, 141
- plasma parameter, 45
- plasma wave, 69, 141
- Poisson brackets, 16

- Poisson equation, 51, 139
- polarized coordinates, 120
- postulates of statistics, 21
- potential
 - complex, 250
 - conjugate harmonic, 251
 - Coulomb, 133
 - Euler, 258
 - gravitational, 344
 - magnetic field, 227
 - vector, 247
- Poynting vector, 17, 214, 240, 388
- pressure
 - partial, 207
 - total, 207
- pressure tensor, 165, 170, 172
- probability density, 24
- prominence, 14, 358, 389
- protostar, 379
- pulsar
 - magnetosphere, 127
- quasar, 370
- radiation
 - synchrotron, 101
- radiation belts, 113
- radiation reaction, 99
- radio source
 - extragalactic, 369
- Rankine-Hugoniot relation, 291, 300, 323
- reconnection
 - collisionless, 14, 196
 - magnetic, 171, 233, 390
- reduced mass, 134
- refraction index, 129, 190
- resonance
 - Landau, 39, 117
- reverse current, 41, 55, 68, 158
- Reynolds number
 - hydrodynamic, 125, 218
 - magnetic, 218
- RHESSI, 76
- rigidity, 82
 - threshold, 113
- ring current, 113
- rotation
 - differential, 225, 371
- runaway
 - electric, 71, 155, 183
 - thermal, 158
- Rutherford formula, 51, 134
- scaling law
 - Kolmogorov, 126
- separation
 - charge, 136
 - MHD, 361
- separator, 246
- Shafranov theorem, 352
- shear, 229
- shock wave
 - collisionless, 289, 298, 337
 - discontinuity surface, 280
 - fast
 - evolutionarity, 312
 - high Mach number, 149, 299
 - intermediate *or* transalvénic, 293
 - interplanetary, 337
 - longitudinal, 297
 - oblique, 290
 - fast, 291, 297
 - slow, 291, 297
 - perpendicular, 287, 297
 - propagation order, 313
 - Rankine-Hugoniot relation, 291, 323
 - slow
 - evolutionarity, 312
 - switch-off, 294
 - switch-on, 294
- soft gamma-ray repeater, 259
- SOHO, 148, 373
- solar atmosphere, 41, 136, 141, 314
- solar corona, 97, 101, 123, 158, 184, 198, 203, 221, 272, 274, 389
- solar photosphere, 14
- solar wind, 177, 183, 331
- sound velocity, 264, 277

- space
 - phase, 3, 19
- special relativity, 215
- specific enthalpy, 171, 214, 300
- specific magnetic volume, 356
- specific volume, 300
- spectrum
 - injection, 61
- Störmer solutions, 112
- star
 - AM Herculis, 231
 - binary, 150, 229
 - cataclysmic variable, 231
 - class A, 348
 - cold giant, 348
 - collapse, 258, 348
 - DQ Herculis, 231
 - formation, 379
 - in galaxy, 46, 160, 178
 - magnetar, 99
 - neutron, 150, 259, 349
 - nova, 257
 - polars, 231
 - rotation, 372
 - Sun, 213, 348
 - supernova, 101, 110, 149, 257, 259, 299, 330
 - white dwarf, 16, 36, 49, 99, 231
- statistical averaging, 24
- stochastic acceleration, 122
- stream function, 256
- substantial derivative, 173, 228
- Sun
 - active region, 353
 - chromosphere, 106, 144, 378
 - corona, 110, 274, 389
 - photosphere, 378
 - prominence, 358
 - rotation, 372
- superstrong magnetic field, 99
- synchrotron radiation, 101
- Syrovatskii, 281, 308, 368
- tachocline, 373
- tangential discontinuity, 297
- evolutionarity, 313
- hydrodynamics, 280, 326
- ideal MHD, 285, 368
- stability, 285
- weak, 270
- temperature, 136, 171
- tensor
 - conductivity, 199
 - Maxwellian stress, 344
 - momentum flux density, 165, 207, 213, 220
 - pressure, 165, 170, 172
 - unit antisymmetric, 102
 - viscous stress, 172, 191, 214, 384
- theorem
 - Irnshow, 352
 - Jeans, 15, 117
 - Liouville, 6
 - Shafranov, 352
 - virial, 15, 343
 - Zempen, 291
- thermal conductivity, 214
- thermal energy, 345
- theta-pinch, 246
- thick target, 60
- threshold rigidity, 113
- transfer coefficients, 175, 298
- transfer equations, 123, 164, 173
- trapped particle, 98, 107, 113, 338
- triple correlation function, 33, 43
- turbulence
 - fluid, 125
 - helical, 226
 - MHD, 110, 126, 226, 230, 339
 - plasma, 147
 - weak, 120
- two-dimensional problem
 - axisymmetric, 256
 - first type, 245
 - second type, 247
- two-temperature plasma, 143
- vector potential, 247
- velocity
 - drift, 84

- group, 265
- hydrodynamic, 205
- mean thermal, 136
- most probable, 152
- phase, 265
- sound *or* acoustic, 264, 277
- virial theorem, 15
 - scalar, 343
 - tensor, 344
- viscosity
 - dynamic, 191, 380
 - kinematic, 125, 213, 221
- viscosity coefficient, 212
- viscous force, 172
- viscous stress tensor, 172, 191, 214
- Vlasov, 37
- Vlasov equation, 37, 70, 116
 - gravitational analog, 46, 52, 303
- volume charge, 201, 206, 213
- vortex flow, 361
- Voyager, 188

- wave
 - Alfvén, 267, 296, 312, 371
 - kinetic, 132
 - nonlinear, 128
 - relativistic, 128
 - de Broglie, 98
 - dissipative, 312, 317
 - electromagnetic, 188
 - entropy, 266, 308, 312
 - entropy-vortex, 274
 - ion-acoustic, 118, 188
 - Langmuir, 118, 141, 185
 - large-amplitude, 263, 297
 - low-frequency, 187
 - magnetoacoustic, 274, 312
 - fast, 268, 288, 292, 297
 - slow, 268, 292
 - plane, 264, 307
 - shock, 263, 280
 - small-amplitude, 263, 296
 - sound *or* acoustic, 184, 297
 - wistler, 121
- wave cascading, 123
- wave spectral density, 123
- white dwarf, 16, 36, 49, 99, 231

- X-ray binary system, 150
- X-ray cluster, 148
- X-ray emission
 - bremsstrahlung, 67, 98, 144, 149
 - hard, 63, 110, 138, 144, 149
 - polarization, 67
 - soft, 147
- X-type zeroth point, 221, 246, 251
- XMM-Newton, 299

- Yohkoh, 144

- Zeeman effect, 231
- Zemlen theorem, 291

Appendix 1. Acronyms

<i>Acronym</i>	<i>Meaning</i>
ACE	Advanced Composition Explorer
CME	coronal mass ejection
CDS	Coronal Diagnostic Spectrometer
EIT	Extreme ultraviolet Imaging Telescope
FFF	force free (magnetic) field
FIP	first ionization potential
GOES	Geostationary Operational Environmental Satellite
GONG	Global Oscillation Network Group
LDE	long duration event
MDI	Michelson Doppler Imager
PNL	polarity inversion line (of the photospheric magnetic field)
RCL	reconnecting current layer
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic Imager
SHTCL	super-hot turbulent-current layer
SNL	simplified neutral line (of the photospheric magnetic field)
SOHO	Solar and Heliospheric Observatory
SEPs	solar energetic particles
TRACE	Transition Region and Coronal Explorer
VLA	Very Large Array

Appendix 2. Notation

Latin alphabet

<i>Symbol</i>	<i>Description</i>	<i>Introduced in Section (Formula)</i>
A	vector potential of a magnetic field	1.1
<i>d</i>	thickness of non-adiabatic region	9.1
<i>h</i>	magnetic field gradient	1.1
<i>H</i>	Hamiltonian	9.2
\mathcal{H}	magnetic helicity	12.1
<i>K</i>	curvature of a magnetic field line	9.2
<i>l</i>	current layer length	13
$L(T)$	radiative loss function	13
u	electric current velocity	2.3
<i>V</i>	velocity of the plasma flow	13
V_a	gradient of the Alfvén speed	2.1
<i>x</i>	ionisation degree	13

Greek alphabet

<i>Symbol</i>	<i>Description</i>	<i>Introduced in Section (Formula)</i>
ε	dimensionless electric field	9.1
ε_α	small parameter of expansion	10.3
ν_{ni}	neutral-ion mean collisional frequency	13
ξ	displacement of a current layer	10.3
ξ_{\parallel}	dimensionless longitudinal magnetic field	9.1
ξ_{\perp}	dimensionless transverse magnetic field	9.1
ξ	displacement of the medium	2.1
Π	work against the Lorentz force	11.4
τ_r	reconnection time scale	14.4

Appendix 3

Useful Formulae

The most important characteristics of astrophysical plasmas (for more detail see vol. 1, Plasma Astrophysics: Fundamental and Practice)

Alfvén speed

$$V_A = \frac{B}{\sqrt{4\pi\rho}} \approx 2.18 \times 10^{11} \frac{B}{\sqrt{n}}, \quad \text{cm s}^{-1}.$$

Conductivity of magnetized plasma

$$\sigma_{\parallel} = \sigma = \frac{e^2 n}{m_e} \tau_{ei} \approx 2.53 \times 10^8 n (\text{cm}^{-3}) \tau_{ei} (\text{s}), \quad \text{s}^{-1},$$

$$\sigma_{\perp} = \sigma \frac{1}{1 + \left(\omega_B^{(e)} \tau_{ei}\right)^2}, \quad \sigma_H = \sigma \frac{\omega_B^{(e)} \tau_{ei}}{1 + \left(\omega_B^{(e)} \tau_{ei}\right)^2}.$$

Coulomb logarithm

$$\ln \Lambda = \ln \left[\left(\frac{3k_B^{3/2}}{2\pi^{1/2} e^3} \right) \left(\frac{T_e^3}{n_e} \right)^{1/2} \right] \approx \ln \left[1.25 \times 10^4 \left(\frac{T_e^3}{n_e} \right)^{1/2} \right].$$

Cyclotron frequency (or gyrofrequency)

$$\omega_B = \frac{ecB}{\mathcal{E}}.$$

Debye radius ($T_e = T$, $T_i = 0$ or $T_e \gg T_i$)

$$r_D = \left(\frac{k_B T}{4\pi n e^2} \right)^{1/2}.$$

Debye radius in electron-proton thermal plasma ($T_e = T_p = T$)

$$r_D = \left(\frac{k_B T}{8\pi e^2 n} \right)^{1/2} \approx 4.9 \left(\frac{T}{n} \right)^{1/2}, \text{ cm.}$$

Dreicer electric field

$$E_{Dr} = \frac{4\pi e^3 \ln \Lambda}{k_B} \frac{n_e}{T_e} \approx 6.54 \times 10^{-8} \frac{n_e}{T_e}, \text{ V cm}^{-1}.$$

Drift velocity

$$\mathbf{v}_d = \frac{c}{e} \frac{\mathbf{F} \times \mathbf{B}}{B^2}.$$

Electric drift velocity

$$\mathbf{v}_d = c \frac{\mathbf{E} \times \mathbf{B}}{B^2}.$$

Electric field in magnetized plasma

$$E \approx \frac{1}{c} v B \approx 10^{-8} v (\text{cm s}^{-1}) B (\text{G}), \text{ V cm}^{-1}.$$

Electron plasma frequency

$$\omega_{pl}^{(e)} = \left(\frac{4\pi e^2 n_e}{m_e} \right)^{1/2} \approx 5.64 \times 10^4 \sqrt{n_e}, \text{ rad s}^{-1}.$$

Electron-ion collision (energy exchange) time

$$\tau_{ei}(\mathcal{E}) = \frac{m_e m_i [3k_B (T_e/m_e + T_i/m_i)]^{3/2}}{e_e^2 e_i^2 (6\pi)^{1/2} 8 \ln \Lambda}.$$

Gradient drift velocity

$$\mathbf{v}_d = \frac{\mathcal{M}c}{eB} \mathbf{n} \times \nabla B.$$

Larmor frequency of a non-relativistic electron

$$\omega_B^{(e)} = \frac{eB}{m_e c} \approx 1.76 \times 10^7 B (\text{G}), \text{ rad s}^{-1}.$$

Larmor frequency of a non-relativistic proton

$$\omega_B^{(p)} \approx 9.58 \times 10^3 B (\text{G}), \text{ rad s}^{-1}.$$

Larmor radius of a non-relativistic electron

$$r_L^{(e)} = \frac{cp_\perp}{eB} \approx 5.69 \times 10^{-8} \frac{v (\text{cm s}^{-1})}{B (\text{G})}, \text{ cm.}$$

Larmor radius of a non-relativistic proton

$$r_L^{(p)} \approx 1.04 \times 10^{-4} \frac{v \text{ (cm s}^{-1}\text{)}}{B \text{ (G)}}, \text{ cm.}$$

Larmor radius of a non-relativistic *thermal* electrons

$$r_L^{(e)} = \frac{V_{Te}}{\omega_B^{(e)}} \approx 3.83 \times 10^{-2} \frac{\sqrt{T_e \text{ (K)}}}{B \text{ (G)}}, \text{ cm.}$$

Larmor radius of a non-relativistic *thermal* protons

$$r_L^{(p)} = \frac{V_{Tp}}{\omega_B^{(p)}} \approx 1.64 \frac{\sqrt{T_p \text{ (K)}}}{B \text{ (G)}}, \text{ cm.}$$

Lundquist number

$$N_L = \text{Re}_m(V_A, L) = \frac{V_A L}{\nu_m}.$$

Magnetic diffusivity (or viscosity)

$$\nu_m = \frac{c^2}{4\pi\sigma} \approx 7.2 \times 10^{19} \frac{1}{\sigma}, \text{ cm}^2 \text{ s}^{-1}.$$

Magnetic moment of a particle on the Larmor orbit

$$\mathcal{M} = \frac{1}{c} JS = \frac{e \omega_B r_L^2}{2c} = \frac{p_\perp^2}{2mB} = \frac{\mathcal{E}_\perp}{B}.$$

Magnetic Reynolds number

$$\text{Re}_m = \frac{L^2}{\nu_m \tau} = \frac{vL}{\nu_m}$$

Mean thermal velocity of electrons

$$V_{Te} = \left(\frac{3k_B T_e}{m_e} \right)^{1/2} \approx 6.74 \times 10^5 \sqrt{T_e \text{ (K)}}, \text{ cm s}^{-1}.$$

Mean thermal velocity of protons

$$V_{Tp} \approx 1.57 \times 10^4 \sqrt{T_p \text{ (K)}}, \text{ cm s}^{-1}.$$

Sound speed in electron-proton plasma

$$V_s = \left(\gamma_g \frac{p}{\rho} \right)^{1/2} \approx 1.66 \times 10^4 \sqrt{T \text{ (K)}}, \text{ cm s}^{-1}.$$

Thermal electron collisional time

$$\tau_{ee} = \frac{m_e^2}{0.714 e^4 8\pi \ln \Lambda} \frac{V_{Te}^3}{n_e} \approx 4.04 \times 10^{-20} \frac{V_{Te}^3}{n_e}, \text{ s.}$$

Thermal proton collisional time

$$\tau_{pp} = \frac{m_p^2}{0.714 e^4 8\pi \ln \Lambda} \frac{V_{Tp}^3}{n_p} \approx 1.36 \times 10^{-13} \frac{V_{Tp}^3}{n_p}, \text{ s.}$$

Time of energy exchange between electrons and protons

$$\tau_{ep}(\mathcal{E}) \approx 22 \tau_{pp} \approx 950 \tau_{ee}.$$

Appendix 4. Constants

Fundamental physical constants

Speed of light	c	$2.998 \times 10^{10} \text{ cm s}^{-1}$
Electron charge	e	$4.802 \times 10^{-10} \text{ CGSE}$
Electron mass	m_e	$9.109 \times 10^{-28} \text{ g}$
Proton mass	m_p	$1.673 \times 10^{-24} \text{ g}$
Boltzmann constant	k_B	$1.381 \times 10^{-16} \text{ erg K}^{-1}$
Gravitational constant	G	$6.673 \times 10^{-8} \text{ dyne cm}^2 \text{ g}^{-2}$
Planck's constant	h	$6.625 \times 10^{-27} \text{ erg s}$

Some useful constants and units

Ampere (current)	A	$3 \times 10^9 \text{ CGSE}$
Angström (length)	Å	10^{-8} cm
Electron Volt (energy)	eV	$1.602 \times 10^{-12} \text{ erg}$
	eV	11605 K
Gauss (magnetic induction)	G	$3 \times 10^{10} \text{ CGSE}$
Henry (inductance)	H	$1.111 \times 10^{-12} \text{ s}^2 \text{ cm}^{-1}$
Ionization potential of hydrogen		13.60 eV
Joule (energy)	J	10^7 erg
Maxwell (magnetic flux)	M	$3 \times 10^{10} \text{ CGSE}$
Ohm (resistance)	Ω	$1.111 \times 10^{-12} \text{ s cm}^{-1}$
Tesla (magnetic induction)		10^4 Gauss
Volt (potential)	V	$3.333 \times 10^{-3} \text{ CGSE}$
Watt (power)	W	10^7 erg s^{-1}
Weber (magnetic flux)	Wb	10^8 Maxwell

Some astrophysical constants

Astronomical unit	AU	1.496×10^{13} cm
Mass of the Sun	M_{\odot}	1.989×10^{33} g
Mass of the Earth	M_E	5.98×10^{27} g
Solar radius	R_{\odot}	6.960×10^{10} cm
Solar surface gravity	g_{\odot}	2.740×10^4 cm s ⁻²
Solar luminosity	L_{\odot}	3.827×10^{33} erg s ⁻¹
Mass loss rate	\dot{M}_{\odot}	10^{12} g s ⁻¹
Rotation period of the Sun	T_{\odot}	26 days (at equator)

Bibliography

Each reference is cited in the Sections of the book indicated within square brackets.

- Acton, L.: 1996, Coronal structures, local and global, in *Magnetohydrodynamic Phenomena in the Solar Atmosphere: Prototypes of Stellar Magnetic Activity*, eds Y. Uchida, T. Kosugi, and H. Hudson, Dordrecht, Kluwer Academic Publ., p. 3–11. [§ 12.4]
- Acton, L., Tsuneta, S., Ogawara, Y., et al.: 1992, The *Yohkoh* mission for high-energy solar physics, *Science*, v. 258, No. 5082, 618–625. [Intr., § 3.2, § 4.1]
- Akimov, V.V., Ambroz, P., Belov, A.V., et al.: 1996, Evidence for prolonged acceleration in the solar flare of June 15, 1991, *Solar Phys.*, v. 166, No. 1, 107–134. [§ 9.4]
- Alfvén, H. and Carlqvist, P.: 1967, Currents in solar atmosphere and a theory of flares, *Solar Phys.*, v. 1, No. 1, 220–228. [§ 14.2]
- Altyntsev, A.T., Krasov, V.I., and Tomozov V.M.: 1977, Magnetic field dissipation in neutral current sheets, *Solar Phys.*, v. 55, No. 1, 69–81. [§ 3.3]
- Aly, J.J.: 1984, On some properties of force-free fields in infinite regions of space, *Astrophys. J.*, v. 283, No. 1, 349–362. [§ 14.2]
- Aly, J.J.: 1991, How much energy can be stored in a force-free field? *Astrophys. J.*, v. 375, No. 1, L61–L64. [§ 14.2]
- Anderson, J.E.: 1963, *Magnetohydrodynamic Shock Waves*, Cambridge, Massachusetts; M.I.T. Press, p. 226. [§ 10.2]
- Anosov, D.V.: 1969, *Geodesic Flows on Closed Riemannian Manifolds with Negative Curvature*, Providence, Amer. Math. Soc., p. 235. [§ 9.2]
- Antiochos, S.K.: 1998, The magnetic topology of solar eruptions, *Astrophys. J.*, v. 502, L181–L184. [§ 3.2, § 3.4, § 6.4]
- Antiochos, S.K., Karpen, J.T., and DeVore, C.R.: 1996, The nature of magnetic reconnection in the corona, in *Magnetic Reconnection in the*

- Solar Atmosphere*, eds R.D. Bentley and J.T. Mariska, Astron. Soc. of Pacific, Conf. Series, v. 111, p. 79–81. [§ 3.3, § 10.1]
- Antiochos, S.K., DeVore, C.R., and Klimchuk, J.A.: 1999, A model for solar coronal mass ejections, *Astrophys. J.*, v. 510, No. 1, 485–493. [§ 5.5, § 14.5.2]
- Antonucci, E., Benna, C., and Somov, B.V.: 1996, Interpretation of the observed plasma ‘turbulent’ velocities as a result of reconnection in solar flares, *Astrophys. J.*, v. 456, No. 2, 833–839. [§ 7.1, § 12.1]
- Anwar, B., Acton, L.W., Hudson, H.S., et al.: 1993, Rapid sunspot motion during a major solar flare, *Solar Phys.*, v. 147, No. 2, 287–303. [§ 5.1.1]
- Archontis, V., Moreno-Insertis, F., Galsgaard, K., et al.: 2005, The three-dimensional interaction between emerging magnetic flux and a large-scale coronal field: Reconnection, current sheets, and jets, *Astrophys. J.*, v. 635, No. 2, 1299–1318. [3.4.1]
- Arge, C.N. and Mullan, D.J.: 1998, Modelling of magnetic interactions in partially-ionized gas, *Solar Phys.*, v. 182, No. 2, 293–332. [§ 13.4]
- Asai, A., Ishii, T. T., Kurokawa, H., et al.: 2003, Evolution of conjugate footpoints inside flare ribbons during a great two-ribbon flare on 2001 April 10, *Astrophys. J.*, v. 586, 624–629. [5.4.1]
- Aschwanden, M.J. and Alexander, D.: 2001, Flare plasma cooling from 30 MK down to 1 MK modeled from *Yohkoh*, GOES, and TRACE observations during the Bastille day event (14 July 2000), *Solar Phys.*, v. 204, No. 1, 93–121. [§ 4.2.3, § 4.2.4, § 5.1]
- Aschwanden, M.J., Kliem, B., Schwarz, U., et al.: 1998, Wavelet analysis of solar flare hard X-rays, *Astrophys. J.*, v. 505, No. 2, 941–956. [§ 7.3]
- Aschwanden, M.J., Kosugi, T., Hanaoka, Y., et al.: 1999, Quadrupole magnetic reconnection in solar flares. I. Three-dimensional geometry inferred from *Yohkoh* observations, *Astrophys. J.*, v. 526, 1026–1045, [§ 6.4, § 7.2.3]
- Aulanier, G., DeLuca, E.E., Antiochos, S.K., et al.: 2000, The topology and evolution of the Bastille day 1998 flare, *Astrophys. J.*, v. 540, No. 2, 1126–1142. [§ 3.4, § 5.5]
- Ayres, T.R.: 1996, Thermal bifurcation of the solar chromosphere, in *Stellar Surface Structure*, eds K.G. Strassmeier and J.L. Linsky, IAU Symp. **176**, Dordrecht, Kluwer Academic Publ., p. 371–384. [§ 13.5]
- Bagalá, L.G., Mandrini, C.H., Rovira, M.G., et al.: 1995, A topological approach to understand a multi-loop flare, *Solar Phys.*, v. 161, No. 1, 103–121. [Intr., § 3.4, § 6.4, § 14.2]
- Bai, T. and Sturrock, P.A.: 1989, Classification of solar flares, *Ann. Rev. Astron. Astrophys.*, v. 27, 421–467. [§ 9.1, § 9.4]
- Bai, T., Hudson, H.S., Pelling, R.M., et al.: 1983, First-order Fermi acceleration in solar flares as a mechanism for the second-step acceleration

- of protons and electrons, *Astrophys. J.*, v. 267, No. 1, 433–441. [§ 7.3]
- Barnes, G., Longcope, D.W., and Leka, K.D.: 2005, Implementing a magnetic charge topology model for solar active regions, *Astrophys. J.*, v. 629, No. 1, 561–571. [§ 3.2.3]
- Barret, D., Olive, J.F., Boirin, L., et al.: 2000, Hard X-ray emission from low-mass X-ray binaries, *Astrophys. J.*, v. 533, 329–351. [§ 8.3]
- Batchelor, G.K.: 1950, On the spontaneous magnetic field in a conducting liquid in turbulent motion, *Proc. Royal Soc.*, v. A201, 405–416. [§12.1]
- Baum, P.J., Bratenahl, A., and Kamin, G.: 1978, Current interruption and flux transfer solar flare models, *Astrophys. J.*, v. 226, No. 1, 286–300. [§ 3.3, § 14.2]
- Bednarek, W. and Protheroe, R.J.: 1999, Gamma-ray and neutrino flares produced by protons accelerated on an accretion disc surface in active galactic nuclei, *Mon. Not. Royal Astron. Soc.*, v. 302, 373–380. [§ 8.3]
- Begelman, M.C., Blandford, R.D., and Rees, M.J.: 1984, Theory of extragalactic radio sources, *Rev. Mod. Phys.*, v. 56, No. 2, 255–351. [Intr.]
- Bentley, R.D., Klein, K.-L., van Driel-Gesztelyi, L., et al.: 2000, Magnetic activity associated with radio noise storms, *Solar Phys.*, v. 193, No. 1–2, 227–245. [§ 3.4]
- Benz, A.: 2002, *Plasma Astrophysics: Kinetic Processes in Solar and Stellar Coronae, Second Edition*, Dordrecht, Kluwer Academic Publ., p. 299. [§ 4.2.5, § 7.4.4, § 7.5]
- Benz, A. and Krucker, S.: 1998, Heating events in the quiet solar corona, *Solar Phys.*, v. 182, No. 2, 349–363. [§ 12.4]
- Benz, A. and Krucker, S.: 1999, Heating events in the quiet solar corona: Multiwavelength correlations, *Astron. Astrophys.*, v. 341, No. 1, 286–295. [§ 12.4]
- Benz, A.O., Lin, R.P., Sheiner, O.A., et al.: 2001, The source regions of impulsive solar electron events, *Solar Phys.*, v. 203, No. 1, 131–144. [§ 9.4]
- Berger, M.A.: 1984, Rigorous limits on magnetic helicity dissipation in the solar corona, *Geophys. Astrophys. Fluid Dyn.*, v. 30, No. 1, 79–104. [§ 12.1]
- Berger, M.A.: 1988a, Three-dimensional reconnection from a global viewpoint, in *Reconnection in Space Plasma*, eds T.D. Guyenne and J.J. Hunt, ESA SP-285, v. 2, p. 83–86. [§ 12.1, § 14.2]
- Berger, M.A.: 1988b, An energy formula for nonlinear force-free fields, *Astron. Astrophys.*, v. 201, No. 1, 355–361. [§ 12.1, § 12.2]
- Berger, M.A.: 1994, Coronal heating by dissipation of magnetic structure, *Space Sci. Rev.*, v. 68, No. 1, 3–14. [§ 12.2]
- Birk, G.T. and Otto, A.: 1991, The resistive tearing instability for generalized resistivity models, *Phys. Fluids*, v. 3, No. B7, 1746–1754. [§ 11.1]

- Biskamp, D.: 1986, Magnetic reconnection via current sheets, *Phys. Fluids*, v. 29, No. 5, 1520–1531. [§ 3.2, § 10.1, § 10.5]
- Biskamp, D.: 1994, Resistive and collisionless magnetic reconnection, in *Plasma Astrophysics*, eds C. Chiudery and G. Einaudi, pp. 1-29, Berlin, Springer-Verlag. [§ 6.4]
- Biskamp, D.: 1997, *Nonlinear Magnetohydrodynamics*, Cambridge Univ. Press, p. 378. [§ 3.2, § 6.1, § 10.1, § 10.5]
- Bogachev, S.A., Somov, B.V., and Masuda, S.: 1998, On the velocity of a hard X-ray source in the solar corona. *Astronomy Letters*, v. 24, No. 4, 543–548. [§ 7.3]
- Bogachev, S.A., Somov, B.V., Kosugi, T., et al.: 2005, The motions of the hard X-ray sources in solar flares: Images and statistics, *Astrophys. J.*, v. 630, No. 1, 561–572. [§ 5.4.5]
- Bogdanov, S.Yu., Frank, A.G., Kyrei, N.P., et al.: 1986, Magnetic reconnection, generation of plasma fluxes and accelerated particles in laboratory experiments, in *Plasma Astrophys.*, ESA SP-251, 177-183. [§ 3.3]
- Bogdanov, S.Yu., Kyrei, N.P., Markov, V.S., et al.: 2000, Current sheets in magnetic configurations with singular X-lines, *JETP Letters*, v. 71, No. 2, 78–84. [3.3]
- Borovsky, J.E. and Funsten, H.O.: 2003, MHD turbulence in the Earth's plasma sheet: Dynamics, dissipation, and driving, *J. Geophys. Res.*, v. 108, No. A7, 1284–1293. [§ 12.1.3]
- Brandenburg, A.: 2001, An inverse cascade and nonlinear α -effect in simulations of isotropic helical hydromagnetic turbulence, *Astrophys. J.*, v. 550, No. 2, 824–840. [§ 12.1]
- Brandenburg, A. and Subramanian, K.: 2000, Large scale dynamos with ambipolar diffusion nonlinearity, *Astron. Astrophys.*, v. 361, L33-L36. [§ 12.1]
- Brissaud, A., Frisch, U., Leorat, J., et al.: 1973, Helicity cascades in fully developed isotropic turbulence, *Phys. Fluids*, v. 16, 1366-1367. [§ 12.1]
- Browning, P.K.: 1988, Helicity injection and relaxation in a coronal magnetic loop with a free surface, *J. Plasma Phys.*, v. 40, No. 2, 263–280. [§ 12.2]
- Brushlinskii, K.V., Zaborov, A.M., and Syrovatskii, S.I.: 1980, Numerical analysis of the current sheet near a magnetic null line, *Soviet J. Plasma Physics*, v. 6, No. 2, 165–173. [§ 3.2, § 3.3, § 10.1, § 10.5]
- Büchner, J. and Zelenyi, L.: 1989, Regular and chaotic particle motion in magnetotail field reversal, *J. Geophys. Res.*, v. 94, No. A9, 11821–11842. [§ 9.2]
- Canfield, R.C., Hudson, H.S., and McKenzie, D.E.: 1999, Sigmoidal morphology and eruptive solar activity, *Geophys. Res. Lett.*, v. 26, No. 6, 627–630. [§ 3.2]

- Cattaneo, F.: 1999, On the origin of magnetic fields in the quiet photosphere, *Astrophys. J.*, v. 515, No. ?, L39–L42. [§ 12.1]
- Chae, J., Wang, H., Qiu, J., et al.: 2001, The formation of a prominence in active region NOAA 8668. 1. SOHO/MDI observations of magnetic field evolution, *Astrophys. J.*, v. 560, No. 1, 476–489. [§ 5.3]
- Chapman, S. and Kendall, P.C.: 1963, Liquid instability and energy transformation near magnetic neutral line. A soluble non-linear hydromagnetic problem, *Proc. Roy. Soc. London*, v. A271, 435–448. [§ 2.4]
- Chen, J. and Palmadesso, P.J.: 1986, Chaos and nonlinear dynamics of single particle orbits in a magnetotail field, *J. Geophys. Res.*, v. 91, No. A2, 1499–1508. [§ 9.2]
- Cho, J. and Vishniac, E.T.: 2000a, The anisotropy of magnetohydrodynamic Alfvénic turbulence, *Astrophys. J.*, v. 539, No. 1, 273–282. [§ 12.1]
- Cho, J. and Vishniac, E.T.: 2000b, The generation of magnetic fields through driven turbulence, *Astrophys. J.*, v. 538, No. 1, 217–225. [§ 12.1]
- Chupp, E.L.: 1996, in *High Energy Solar Physics*, eds R. Ramaty, N. Mandzhavidze, and X.-M. Hua, AIP Conf. Proc. 374, AIP, Woodbury, New York, 3–9, 1996. [§ 9.4]
- Colgate, S.A.: 1988, Relationship between high-energy phenomena on the Sun and in astrophysics, *Solar Phys.*, v. 118, No. 1, 1–15. [§ 9.4]
- Colgate, S.A. and Furth, H.P.: 1960, Stabilization of pinch discharges, *Phys. Fluids*, v. 3, No. 6, 982–1000. [§ 11.1]
- Coppi, B., Laval, G., and Pellat, R.: 1966, Dynamics of the geomagnetic tail, *Phys. Rev. Lett.*, v. 6, No. 26, 1207–1210. [§ 11.1, § 11.6]
- Cowley, S.W.H.: 1986, Magnetic reconnection, in *Solar System Magnetic Fields*, ed. E.R. Priest, Dordrecht, D. Reidel Publ., p. 121–134. [§ 1.2]
- Cox, D.P. and Tucker, W.H.: 1969, Ionization equilibrium and radiative cooling of a low-density plasma, *Astrophys. J.*, v. 157, No. 3, 1157–1167. [§ 6.1.2]
- Craig, I.J.D. and McClymont, A.N.: 1993, Linear theory of reconnection at an X-type neutral point, *Astrophys. J.*, v. 405, No. 1, 207–215. [§ 13.2.3]
- Crooker, N., Joselyn, J.A., and Feynman, J. (eds): 1997, *Coronal Mass Ejections*, Washington, Amer. Geophys. Un., p. 299. [Intr.]
- Crooker, N.U., Gosling, J.T., and Kahler, S.W.: 2002, Reducing heliospheric magnetic flux from coronal mass ejections without disconnection, *J. Geophys. Res.*, v. 107, No. A2, SSH 3-1. [§ 5.2.2]
- Day, C.: 1998, SOHO observations implicate ‘magnetic carpet’ as source of coronal heating in quiet Sun, *Physics Today*, March issue, 19–21. [§ 12.4]

- de Jager, C.: 1986, Solar flares and particle acceleration, *Space Sci. Rev.*, v. 44, No. 1, 43–90. [§ 12.1]
- de Jager, C.: 2005, Solar forcing of climate. 1: Solar variability, *Space Sci. Rev.*, v. 120, No. 1, 197–241. [Intr., § 8.2.2]
- de Kluiver, H., Perepelkin, N.F., and Hirose, A.: 1991, Experimental results on current-driven turbulence in plasmas - A survey, *Physics Reports* (Review Section of Physics Letters), v. 199, No. 6, 281–381. [§ 8.1]
- Démoulin, P., van Driel-Gesztelyi, L., Schmieder, B., et al.: 1993, Evidence for magnetic reconnection in solar flares. *Astron. Astrophys.*, v. 271, No. 1, 292–307. [Intr., § 3.4, § 6.4, § 14.2]
- Den, O.G. and Somov, B.V.: 1989, Magnetic field dissipation in a high-temperature plasma as a mechanism of energy release in a solar flare, *Soviet Astronomy-AJ*, v. 33, No. 2, 149–155. [§ 3.2, § 3.3, § 7.1, § 14.2]
- Deng, Y., Wang, J., Yan, Y., et al.: 2001, Evolution of magnetic nonpotentiality in NOAA AR 9077, *Solar Phys.*, v. 204, No. 1, 13–28. [§ 4.2.4, § 5.1, § 5.5]
- Dennis, B.R.: 1985, Solar hard X-ray bursts. *Solar Phys.*, v. 100, No. 2, 465–490. [§ 7.1]
- Dennis, B.R.: 1988, Solar flare hard X-ray observations, *Solar Phys.*, v. 118, No. 1, 49–94. [§ 7.1]
- Dobrowolny, M.: 1968, Instability of a neutral sheet, *Nuovo Cimento*, v. B55, No. 1, 427–438. [§ 9.3]
- Domingo, V., Fleck, B., and Poland, A.A.: 1995, SOHO: the solar and heliospheric observatory, *Space Sci. Rev.*, v. 72, No. 1, 81–84. [Intr., § 4.1]
- Dreicer, H.: 1959, Electron and ion runaway in a fully ionized gas, *Phys. Rev.*, v. 115, No. 2, 238–249. [§ 6.1]
- Duijveman, A., Hoyng P., and Ionson, J.A.: 1981, Fast plasma heating by anomalous and inertial resistivity effects in the solar atmosphere, *Astrophys. J.*, v. 245, No. 2, 721–735. [§ 6.3]
- Dungey, J.W.: 1958, *Cosmic Electrodynamics*, England, Cambridge Univ. Press, p. 183. [Intr., § 1.1, § 2.1, § 11.1, § 14.2]
- Dungey, J.W.: 1961, Interplanetary magnetic field and the auroral zones, *Phys. Rev. Lett.*, v. 6, No. 2, 47–48. [§ 8.2]
- Efthymiopoulos, C., Gontikakis, C., and Anastasiadis, A.: 2005, Particle dynamics in 3D reconnecting current sheets in the solar atmosphere, *Astron. Astrophys.*, v. 443, No. 2, 663–678. [§ 9.1.5]
- Fang, C. and Ding, M.D.: 1995, On the spectral characteristics and atmosphere models of the two types of white-light flares, *Astron. Astrophys. Suppl.*, v. 110, No. 1, 99–106. [§ 13.2.1]
- Field, G.B.: 1965, Thermal instability, *Astrophys. J.*, v. 142, No. 2, 531–567. [§ 3.3, § 6.1]

- Fletcher, L.: 1995, On the generation of loop-top impulsive hard X-ray sources, *Astron. Astrophys.*, v. 303, No. 1, L9–L12. [§ 7.3.1]
- Fletcher, L. and Hudson, H.: 2001, The magnetic structure and generation of EUV flare ribbons, *Solar Phys.*, v. 204, No. 1, 71–91. [§ 4.1, § 4.2.3, § 4.2.4, § 5.1]
- Fletcher, L. and Hudson, H.: 2002, Spectral and spatial variations of flare hard X-ray footpoints, *Solar Phys.*, v. 210, No. 1, 307–321. [Intr., § 5.4.1]
- Forbes, T.G. and Acton, L.W.: 1996, Reconnection and field line shrinkage in solar flares, *Astrophys. J.*, v. 459, No. 1, 330–341. [§ 4.1, § 4.2.4, § 5.4.1]
- Froyland, J.: 1992, *Introduction to Chaos and Coherence*, Bristol, Philadelphia, Tokyo; Inst. of Phys. Publ., p. 156. [§ 9.2]
- Furth, H.P.: 1961, Sheet pinch instabilities caused by finite conductivity, *Bull. Amer. Phys. Soc.*, v. 6, No. 2, p. 193. [§ 11.1]
- Furth, H.P.: 1967, *Proc. ESRW Conf. of the Stability of Plane Plasmas*, Frascati, Eur. Space Res. Inst., p. 22–25. [§ 11.1]
- Furth, H.P., Killen, J., and Rosenbluth, M.N.: 1963, Finite-resistivity instabilities of a sheet pinch, *Phys. Fluids*, v. 6, No. 4, 459–484. [§ 4.2.4, § 11.1, § 11.2, § 11.3]
- Galeev, A.A. and Zelenyi, L.M.: 1975, Metastable states of neutral sheet and the substorms, *JETP-Lett.*, v. 22, No. 7, 170–172. [§ 11.1, § 11.6]
- Galeev, A.A. and Zelenyi, L.M.: 1976, Tearing instability in plasma configurations, *Soviet Physics-JETP*, v. 43, No. 6, 1113–1123. [§ 11.1, § 11.6]
- Galeev, A.A., Rosner, R., and Vaiana, G.S.: 1979, Structured coronae of accretion discs, *Astrophys. J.*, v. 229, No. 1, 318–326. [Intr., § 8.3]
- Gal’per, A.M., Zemskov, V.M., Luchkov, B.I., et al.: 1994, Temporal fine structure in hard γ radiation in solar flares, *JETP Lett.*, v. 59, No. 3, 153–157. [§ 9.4]
- Galsgaard, K. and Longbottom, A.W.: 1999, Formation of solar prominences by flux convergence, *Astrophys. J.*, v. 510, No. 1, 444–459. [§ 13.3]
- Giovanelli, R.G.: 1946, A theory of chromospheric flares, *Nature*, v. 158, No. 4003, 81–82. [Intr., § 1.1, § 14.2]
- Giovanelli, R.G.: 1947, Magnetic and electric phenomena in the sun’s atmosphere associated with sunspots, *Mon. Not. Royal Astron. Soc.*, v. 107, No. 4, 338–355. [§ 2.1, § 14.2]
- Giovanelli, R.G.: 1948, Chromospheric flares, *Mon. Not. Royal Astron. Soc.*, v. 108, No. 2, 163–176. [§ 14.2]
- Giuliani, P., Neukirch, T., and Wood, P.: 2005, Particle motion in collapsing magnetic traps in solar flares. 1. Kinematic theory of collapsing

- magnetic traps, *Astrophys. J.*, v. 635, No. 1, 636–646. [§ 7.3.2, § 7.4.2]
- Glover, A., Ranns, N.D.R., Harra, L.K., et al.: 2000, The onset and association of CMEs with sigmoidal active regions, *Geophys. Res. Lett.*, v. 27, No. 13, 2161–2164. [§ 3.2]
- Gold, T.: 1964, Magnetic energy shedding in the solar atmosphere, in *AAS-NASA Symp. in the Physics of Solar Flares*, ed. W.N. Hess, NASA-SP 50, Washington DC, p. 389–396. [§ 12.4]
- Gold, T. and Hoyle, F.: 1960, On the origin of solar flares, *Monthly Not. Royal Astron. Soc.*, v. 120, No. 2, 89–105. [§ 3.2, § 12.2, § 14.2]
- Goldreich, P. and Sridhar, S.: 1997, Magnethydrodynamic turbulence revisited, *Astrophys. J.*, v. 485, No. 2, 680–688. [§ 12.1]
- Golub, L., Bookbinder, J., DeLuca, E., et al.: 1999, A new view of the solar corona from the transition region and coronal explorer (TRACE), *Phys. Plasmas*, v. 6, No. 5, 2205–2212. [Intr.]
- Gopasyuk, S.I.: 1990, Solar magnetic fields and large-scale electric currents in the active regions, *Adv. Space Res.*, v. 10, No. 9, 151–160. [§ 3.3]
- Gorbachev, V.S. and Somov, B.V.: 1988, Photospheric vortex flows as a cause for two-ribbon flares: A topological model, *Solar Phys.*, v. 117, No. 1, 77–88. [§ 3.2, § 3.4, § 5.2.3]
- Gorbachev, V.S. and Somov, B.V.: 1989, Solar flares of November 5, 1980, as the result of magnetic reconnection at a separator, *Soviet Astronomy-AJ*, v. 33, No. 1, 57–61. [Intr., § 3.2, § 3.4, § 5.4.2, § 6.4, § 14.3]
- Gorbachev, V.S. and Somov, B.V.: 1990, Magnetic reconnection on the separator as a cause of a two-ribbon flare, *Adv. Space Res.*, v. 10, No. 9, 105–108. [Intr., § 3.2, § 3.4, § 4.2.3, § 6.4, § 14.3]
- Gorbachev, V.S., Kel’ner, S.R., Somov, B.V., et al.: 1988, New topological approach to the question of solar flare trigger, *Soviet Astronomy-AJ*, v. 32, No. 3, 308–314. [§ 3.2, § 5.1]
- Gosling, J.T., Birn, J., and Hesse, M.: 1995, Three-dimensional magnetic reconnection and the magnetic topology of coronal mass ejection events, *Geophys. Res. Lett.*, v. 22, No. 8, 869–872. [§ 5.2.2]
- Groth, C.P.T., De Zeeuw, D.L., Gombosi, T.I., et al.: 2000, Global three-dimensional MHD simulation of a space weather event: CME formation, interplanetary propagation, and interaction with the magnetosphere, *J. Geophys. Res.*, v. 105, No. A11, 25053–25078. [§ 8.2]
- Guckenheimer, J. and Holmes, P.: 1983, *Nonlinear Oscillations, Dynamical Systems and Bifurcations of Vector Fields*, New York, Springer-Verlag. [§ 11.6]
- Gurevich, A.V.: 1961, On the theory of runaway electrons, *Soviet Physics-JETP*, v. 12, No. 5, 904–912. [§ 6.1]
- Gurevich, A.V. and Zhivlyuk, Y.N.: 1966, Runaway electrons in a non-equilibrium plasma, *Soviet Physics-JETP*, v. 22, No. 1, 153–159. [§ 6.1]

- Haisch, B.M., Strong, K.T., and Rodonò M.: 1991, Flares on the Sun and other stars, *Ann. Rev. Astron. Astrophys.*, v. 29, 275–324. [Intr.]
- Haken, H.: 1978, *Synergetics*, New York, Springer-Verlag. [§ 11.6]
- Hanslmeier, A.: 2002, *The Sun and Space Weather*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 243. [Intr., § 8.2]
- Hargreaves, J.K.: 1992, *The Solar-Terrestrial Environment*, Cambridge, UK; Cambridge Univ. Press, p. 420. [Intr.]
- Harra-Murnion, L.K., Schmieder, B., van Driel-Gestelyi, L., et al.: 1998, Multi-wavelength observations of post flare loops in two long duration solar flares, *Astron. Astrophys.*, v. 337, 911–920. [§ 7.2.2]
- Harris, E.G.: 1962, On a plasma sheath separating regions of oppositely directed magnetic field, *Nuovo Cimento*, v. 23, No. 1, 115–121. [§ 9.3, § 9.4, § 11.6]
- Hénoux, J.-C. and Somov, B.V.: 1987, Generation and structure of the electric currents in a flaring activity complex, *Astron. Astrophys.*, v. 185, No. 1, 306–314. [§ 5.2.3, § 14.2]
- Hénoux, J.-C. and Somov, B.V.: 1991, The photospheric dynamo. 1. Magnetic flux-tube generation, *Astron. Astrophys.*, v. 241, No. 2, 613–617. [§ 13.5, § 13.6]
- Hénoux, J.-C. and Somov, B.V.: 1992, First ionization potential fractionation, in *Coronal Streamers, Coronal Loops, and Coronal and Solar Wind Composition*, Proc. First SOHO Workshop, ESA SP-348, p. 325–330. [§ 13.5]
- Hénoux, J.-C. and Somov, B.V.: 1997, The photospheric dynamo. 2. Physics of thin magnetic flux tubes, *Astron. Astrophys.*, v. 318, No. 3, 947–956. [§ 13.5]
- Hénoux, J.-C. and Somov, B.V.: 1999, Physics of thin flux tubes in a partially ionized atmosphere, in *Third Advances in Solar Physics Euroconference: Magnetic Fields and Oscillations*, eds B. Schmieder, A. Hofmann, and J. Staude, ASP Conference Series, v. 184, 55–59. [§ 13.5]
- Hesse, M., Birn, J., Baker, D.N., and Slavin, J.A.: 1996, MHD simulation of the transition of reconnection from closed to open field lines, *J. Geophys. Res.*, v. 101, No. A5, 10805–10816. [§ 6.2]
- Heyvaerts, J. and Priest, E.R.: 1984, Coronal heating by reconnection in DC current systems. A theory based on Taylor’s hypothesis, *Astron. Astrophys.*, v. 137, No. 1, 63–78. [§ 12.2]
- Hirano, Y., Yagi, Y., Maejima, Y., et al.: 1997, Self-organization and its effect on confinement in a reversed field pinch plasma, *Plasma Phys. Control. Fusion*, v. 39, No. 5A, A393–A400. [§ 12.1]
- Hirose, S., Uchida, Y., Uemura, S., et al.: 2001, A quadruple magnetic source model for arcade flares and X-ray arcade formations outside active regions. II. Dark filament eruption and the associated arcade flare,

- Astrophys. J.*, v. 551, No. 1, 586–596. [§ 5.2.2]
- Hoh, F.C.: 1966, Stability of sheet pinch, *Phys. Fluids*, v. 9, 277–284. [§ 9.3]
- Hones, E.W.Jr.(ed.): 1984, *Magnetic Reconnection in Space and Laboratory Plasmas*, Washington, Amer. Geophys. Un., p. 386. [§ 14.2]
- Horiuchi, R. and Sato, T.: 1994, Particle simulation study of driven reconnection in a collisionless plasma, *Phys. Plasmas*, v. 1, No. 11, 3587–3597. [§ 6.1]
- Horiuchi, R. and Sato, T.: 1997, Particle simulation study of collisionless driven reconnection in a sheared magnetic field, *Phys. Plasmas*, v. 4, No. 2, 277–289. [§ 6.2, § 6.4, § 7.1, § 9.2]
- Horiuchi, R., Pei, W. and Sato, T.: 2001, Collisionless driven reconnection in an open system, *Earth Planets Space*, v. 53, No. 6, 439–445. [§ 6.2, § 6.4]
- Horwitz, J.L., Gallagher, D.L., and Peterson, W.K. (eds): 1998, *Geospace Mass and Energy Flow*, Washington, Amer. Geophys. Un., p. 393. [Intr.]
- Hudson, H. and Ryan, J.: 1995, High-energy particles in solar flares, *Ann. Rev. Astron. Astrophys.*, v. 33, 239–282. [7.3.1, § 9.1]
- Hudson, H.S., Lemen, J.R., St. Cyr, O.C., et al.: 1998, X-ray coronal changes during halo CMEs, *Geophys. Res. Lett.*, v. 25, No. 14, 2481–2484. [§ 3.2]
- Hurford, G.J., Schwartz, R.A., Krucker, S., et al.: 2003, First gamma-ray images of a solar flare, *Astrophys. J.*, v. 595, No. 2, L77–L80. [Intr.]
- Ichimoto, K., Hirayama, T., Yamaguchi, A., et al.: 1992, Effective geometrical thickness and electron density of a flare of 1991 December 2, *Publ. Astron. Soc. Japan*, v. 44, No. 5, L117–L122. [Intr.]
- Imshennik, V.S. and Syrovatskii, S.I.: 1967, Two-dimensional flow of an ideally conducting gas in the vicinity of the zero line of a magnetic field, *Soviet Physics-JETP*, v. 25, No. 4, 656–664. [§ 2.4]
- Ip, J.T.C. and Sonnerup, B.U.: 1996, Resistive tearing instability in a current sheet with coplanar viscous stagnation-point flow, *J. Plasma Phys.*, v. 56, No. 2, 265–284. [§ 11.5]
- Iroshnikov, P.S.: 1964, Turbulence of a conducting fluid in a strong magnetic field, *Soviet Astronomy-AJ.*, v. 7, No. 4, 566–571. [§ 12.1]
- Isliker, H.: 1992, Structural properties of the dynamics in flares, *Solar Phys.*, v. 141, No. 2, 325–334. [§ 9.2]
- Jacobsen, C. and Carlqvist, P.: 1964, Solar flares caused by circuit interruptions, *Icarus*, v. 3, No. 3, 270–272. [§ 14.2]
- Janicke, L.: 1980, The resistive tearing mode in weakly two-dimensional neutral sheets, *Phys. Fluids*, v. 23, No. 9, 1843–1849. [§ 11.1]

- Janicke, L.: 1982, Resistive tearing mode in coronal neutral sheets, *Solar Phys.*, v. 76, No. 1, 29–43. [§ 11.1]
- Kan, J.R., Akasofu, S.I., and Lee, L.C.: 1983, A dynamo theory of solar flares, *Solar Phys.*, v. 84, No. 1, 153–167. [§ 3.3]
- Karpen, J.T., Antiochos, S.K., and De Vore, C.R.: 1991, Coronal current sheet formation: The effect of asymmetric and symmetric shears, *Astrophys. J.*, v. 382, No. 1, 327–337. [§ 14.2, § 14.4]
- Karpen, J.T., Antiochos, S.K., De Vore, C.R., et al.: 1998, Dynamic responses to reconnection in solar arcades, *Astrophys. J.*, v. 495, No. 1, 491–501. [§ 3.1, § 10.1]
- Kivelson, M.G. and Russell, C.T. (eds): 1995, *Introduction to Space Physics*, Cambridge, Cambridge Univ. Press, p. 568. [Intr., § 8.2]
- Klein, K.-L., Chupp, E.L., Trotter, G., et al.: 1999, Flare-associated energetic particles in the corona and at 1 AU, *Astron. Astrophys.*, v. 348, No. 1, 271–285. [§ 9.4]
- Klein, K.-L., Trotter, G., Lantos, P., et al.: 2001, Coronal electron acceleration and relativistic proton production during the 14 July 2000 flare and CME, *Astron. Astrophys.*, v. 373, 1073–1082. [§ 5.2.2]
- Kokubun, S. and Kamide, Y. (eds): 1998, *Substorms-4*, Dordrecht, Kluwer Academic Publ.; Tokyo, Terra Scientific Publ., p. 823. [Intr., § 11.6]
- Kontorovich, V.M.: 1959, On the interaction between small perturbations and the discontinuities in MHD and the stability of shock waves, *Soviet Physics-JETP*, v. 8, No. 5, 851–858. [§ 10.2]
- Kopp, R.A. and Pneuman, G.W.: 1976, Magnetic reconnection in the corona and the loop prominence phenomenon, *Solar Phys.*, v. 50, No. 1, 85–94. [§ 5.4.1]
- Kosovichev, A.G., and Zharkova, V.V.: 2001, Magnetic energy release and transients in the solar flare of 2000 July 14, *Astrophys. J.*, v. 550, Part 2, L105–L108. [§ 5.1.1, § 5.3]
- Kosugi, T.: 1996, Solar flare energy release and particle acceleration as revealed by *Yohkoh* HXT, in *High Energy Solar Physics*, eds R. Ramaty, N. Mandzhavidze, and X.-M. Hua, New York, American Inst. of Phys., p. 267–276. [§ 7.3.1]
- Kosugi, T. and Somov, B.: 1998, Magnetic reconnection and particle acceleration in solar flares, in *Observational Plasma astrophysics: Five Years of Yohkoh and Beyond*, eds T. Watanabe, T. Kosugi, and A.C. Sterling, Dordrecht, Kluwer Academic Publ., p. 297–306. [Intr., § 9.4]
- Kosugi, T., Dennis, B.R., and Kai, K.: 1988, Energetic electrons in impulsive and extended solar flares as deduced from flux correlation between hard X-rays and microwaves, *Astrophys. J.*, v. 324, 1118–1127. [§ 4.2.5, § 7.5]

- Kosugi, T., Makishima, K., Murakami, T., et al.: 1991, The hard X-ray telescope (HXT) for the Solar-A mission, *Solar Phys.*, v. 136, No. 1, 17–36. [Intr., § 4.1]
- Kosugi, T., Sakao, T., Masuda, S., et al.: 1994, Hard and soft X-ray observations of a super-hot thermal flare of 6 February, 1992, in *New Look at the Sun with Emphasis on Advanced Observations of Coronal Dynamics and Flares*, eds S. Enome and T. Hirayama, (Proc. Kofu Symp., Kofu, Sept. 6–10, 1993), p. 127–129. [§ 7.2.1]
- Kovalev, V.A. and Somov, B.V.: 2003, The role of collisions in the particle acceleration in solar-flare magnetic traps, *Astronomy Letters*, v. 29, No. 6, 465–472. [§ 12.3.1]
- Kraichnan, R.H.: 1965, Inertial-range spectrum of hydromagnetic turbulence, *Phys. Fluids*, v. 8, No. 7, 1385–1389. [§ 12.1]
- Krause, F. and Rädler, K.-H.: 1980, *Mean-Field Magnetohydrodynamics and Dynamo Theory*, Oxford, Pergamon Press. [§ 12.1]
- Krucker, S. and Benz, A.O.: 2000, Are heating events in the quiet solar corona small flares? Multiwavelength observations of individual events, *Solar Phys.*, v. 191, No. 2, 341–358. [§ 12.4]
- Krucker, S., Benz, A.O., and Aschwanden, M.J.: 1997, *Yohkoh* observation of the source regions of solar narrowband, millisecond spike events, *Astron. Astrophys.*, v. 317, No. 2, 569–579. [§ 9.4]
- Krucker, S., Hurford, G.J., and Lin, R.P.: 2003, Hard X-ray source motions in the 2002 July 23 gamma-ray flare, *Astrophys. J.*, v. 595, No. ?, L103–L106. [Intr., § 4.2.5, § 5.4.1, § 7.2.2]
- Kubát, J. and Karlický, M.: 1986, Electric conductivity in the solar photosphere and chromosphere, *Bull. Astron. Inst. Czechosl.*, v. 37, No. 3, 155–163. [§ 13.2.2]
- Kundt, W.: 2001, *Astrophysics: A Primer*, New York, Berlin, Heidelberg, Tokyo; Springer-Verlag, p. 183. [Intr.]
- Kurths, J. and Herzog, H.: 1986, Can a solar pulsation event be characterized by a low-dimensional chaotic attractor? *Solar Phys.*, v. 10, No. 1, 39–45. [§ 9.2]
- Kurths, J., Benz, A., and Aschwanden, M.J.: 1991, The attractor dimension of solar decimetric radio pulsation, *Astron. Astrophys.*, v. 248, No. 1, 270–276. [§ 9.2]
- Kusano, K.: 2005, Simulation study of the formation mechanism of sigmoidal structure in the solar corona, *Astrophys. J.*, v. 631, No. 2, 1260–1269. [§ 5.5, § 12.2.2]
- Kusano, K. and Nishikawa, K.: 1996, Bifurcation and stability of coronal arcades in a linear force-free field, *Astrophys. J.*, v. 461, No. 1, 415–423. [§ 3.1, § 3.3]

- Laming, J.M. and Drake, J.J.: 1999, Stellar coronal abundances. VI. The FIP effect and ξ Bootis A — Solar-like anomalies, *Astrophys. J.*, v. 516, No. 1, 324–334. [§ 13.4]
- Landau, L.D. and Lifshitz, E.M.: 1976, *Mechanics*, 3rd edition, Oxford, London, Paris; Pergamon Press, p. 165. [§ 9.2]
- Landau, L.D., Lifshitz, E.M., and Pitaevskii, L.P.: 1984, *Electrodynamics of Continuous Media*, Oxford, New York; Pergamon Press, p. 460. [§ 10.2.2]
- LaRosa, T.N. and Moore, R.L.: 1993, A mechanism for bulk energization in solar flares: MHD turbulent cascade, *Astrophys. J.*, v. 418, No. 2, 912–918. [§ 12.1]
- LaRosa, T.N., Moore, R.L., Miller, J.A., et al.: 1996, New promise for electron bulk energization in solar flares: Preferential Fermi acceleration of electrons over protons in reconnection-driven MHD turbulence, *Astrophys. J.*, v. 467, No. 1, 454–464. [§ 12.3.1]
- Lau, Y.-T.: 1993, Magnetic nulls and topology in a class of solar flare models, *Solar Phys.*, v. 148, No. 2, 301–324. [§ 3.2, § 14.3]
- Lavrent'ev, M.A. and Shabat, B.V.: 1973, *Methods of the Theory of Complex Variable Functions*, Moscow, Nauka, p. 736 (in Russian). [§ 14.3]
- Leamon, R.J., Smith, C.W., Ness, N.F., et al.: 1998, Observational constraints on the dynamics of the interplanetary magnetic field dissipation range, *J. Geophys. Res.*, v. 103, No. A3, 4775–4787, [§ 12.1]
- Lembege, B. and Pellat R.: 1982, Stability of a thick two-dimensional quasi-neutral sheet, *Phys. Fluids*, v. 25, No. 11, 1995–2004. [§ 11.6]
- Lesch, H. and Pohl, M.: 1992, A possible explanation for intraday variability in active galactic nuclei, *Astron. Astrophys.*, v. 254, No. 1, 29–38. [§ 8.3]
- Li, Y.P. and Gan, W.Q.: The shrinkage of flare radio loops, *Astrophys. J.*, v. 629, No. 2, L137–L139. [§ 7.5]
- Lichtenberg, A.J. and Lieberman, M.A.: 1983, *Regular and Stochastic Motion*, New York, Springer-Verlag, p. 314. [§ 9.2]
- Lin, R.P., Schwartz, R.A., Pelling, R.M., et al.: 1981, A new component of hard X-rays in solar flares, *Astrophys. J.*, v. 251, No. 2, L109–L114. [§ 7.1]
- Lin, R.P., Dennis, B.R., Hurford, G.J., et al.: 2002, The Reuven Ramaty High-Energy Solar Spectroscopic Imager (RHESSI), *Solar Phys.*, v. 210, No. 1, 3–32. [Intr., § 7.2.1]
- Lin, R.P., Krucker, S., Hurford, G.J., et al.: 2003, *RHESSI* observations of particle acceleration and energy release in an intense solar gamma-ray line flare, *Astrophys. J.*, v. 595, No. 2, L69–L76. [Intr., § 4.2.5, § 7.2.2, § 7.5]

- Lin, R.P., Larson, D., McFadden, J., et al.: 1996, Observations of an impulsive solar electron event extending down to ~ 0.5 keV energy, *Geophys. Res. Lett.*, v. 23, No. 10, 1211–1214. [§ 9.4]
- Lin, Y., Wei, X., and Zhang, H.: 1993, Variations of magnetic fields and electric currents associated with a solar flare, *Solar Phys.*, v. 148, No. 1, 133–138. [§ 3.1]
- Litvinenko, Y.E.: 1993, Regular versus chaotic motion of particles in non-neutral current sheets, *Solar Phys.*, v. 147, No. 2, 337–342. [§ 9.2]
- Litvinenko, Y.E.: 1997, Interpretation of particle acceleration in a simulation study of collisionless reconnection, *Phys. Plasmas*, v. 4, No. 9, 3439–3441. [§ 9.2]
- Litvinenko, Y.E.: 1999, Photospheric reconnection and canceling magnetic features on the Sun, *Astrophys. J.*, v. 515, No. 1, 435–440. [§ 12.4, § 13.2.1]
- Litvinenko, Y.E. and Somov, B.V.: 1991, Electron acceleration in current sheets in solar flares, *Soviet Astronomy Lett.*, v. 17, No. 5, 353–356. [§ 9.1]
- Litvinenko, Y.E. and Somov, B.V.: 1993, Particle acceleration in reconnecting current sheets, *Solar Phys.*, v. 146, No. 1, 127–133. [§ 9.2, § 9.3]
- Litvinenko, Y.E. and Somov, B.V.: 1994a, Electromagnetic expulsion force in cosmic plasma, *Astron. Astrophys.*, v. 287, No. 1, L37–L40. [§ 5.3]
- Litvinenko, Y.E. and Somov, B.V.: 1994b, Magnetic reconnection in the temperature minimum and prominence formation, *Solar Phys.*, v. 151, No. 2, 265–270. [§ 5.3, § 12.4, § 13.2.1]
- Litvinenko, Y.E. and Somov B.V.: 1995, Relativistic acceleration of protons in current sheets of solar flares, *Solar Phys.*, v. 158, No. 1, 317–330. [§ 9.3.3, § 9.4]
- Litvinenko, Y.E. and Somov, B.V.: 2001, Aspects of the global MHD equilibria and filament eruptions in the solar corona, *Space Sci. Rev.*, v. 95, No. 1, 67–77. [§ 5.3]
- Liu, C., Deng, N., Liu, Y., et al.: 2005, Rapid change of δ spot structure associated with seven major flares, *Astrophys. J.*, v. 622, No. 1, 722–736. [§ 3.1.1, § 3.1.3]
- Liu, S., Petrosian, V., and Mason, G.M.: 2006, Stochastic acceleration of ^3He and ^4He in solar flares by parallel-propagating plasma waves: General results, *Astrophys. J.*, v. 636, No. 1, 462–474. [§ 12.3.2]
- Liu, Y. and Zhang, H.: 2001, Relationship between magnetic field evolution and major flare event on July 14, 2000, *Astron. Astrophys.*, v. 372, No. 3, 1019–1029. [§ 4.1, § 4.2.3, § 4.2.4, § 4.2.5, § 5.2.3, § 5.3]
- Liu, Y. and Zhang, H.: 2002, Analysis of a delta spot, *Astron. Astrophys.*, v. 386, No. 2, 648–652. [§ 4.1]

- Liu, Y., Srivastava, N., Prasad, D., et al.: 1995, A possible explanation of reversed magnetic field features observed in NOAA AR 7321, *Solar Phys.*, v. 158, No. 1, 249–258. [§ 13.3]
- Longcope, D.W.: 1996, Topology and current ribbons: A model for current, reconnection and flaring, *Solar Phys.*, v. 169, No. 1, 91–121. [§ 3.4, § 4.2.3, § 4.2.4]
- Longcope, D.W. and Cowley, S.C.: 1996, Current sheet formation along 3D magnetic separators, *Phys. Plasmas*, v. 3, No. 8, 2885–2897. [§ 3.2, § 4.2.3]
- Longcope, D.W. and Silva, A.V.R.: 1998, A current ribbon model for energy storage and release with application to the flare of 7 January 1992, *Solar Phys.*, v. 179, No. 2, 349–377. [Intr., § 3.4, § 6.4]
- Longcope, D.W., McKenzie, D.E., Cirtain, J., et al.: 2005, Observations of separator reconnection to an emerging active region, *Astrophys. J.*, v. 630, No. 1, 596–614. [§ 3.3.3, § 3.4.4]
- Longmire, C.L.: 1963, *Elementary Plasma Physics*, New York, London; Interscience Publ., p. 296. [§ 9.3]
- Low, B.C.: 1987, Electric current sheet formation in a magnetic field induced by footpoint displacements, *Astrophys. J.*, v. 323, No. 1, 358–367. [§ 2.1.2]
- Low, B.C.: 1991, On the spontaneous formation of current sheets above a flexible solar photosphere, *Astrophys. J.*, v. 381, No. 1, 295–305. [§ 14.2, § 14.3]
- Low, B.C. and Smith, D.F.: 1993, The free energies of partially open coronal magnetic fields, *Astrophys. J.*, v. 410, No. 1, 412–425. [§ 14.2]
- Low, B.C. and Wolfson, R.: 1988, Spontaneous formation of current sheets and the origin of solar flares, *Astrophys. J.*, v. 324, No. 1, 574–581. [§ 2.1.2]
- Lu, E.T. and Hamilton, R.J.: 1991, Avalanches and distribution of solar flares, *Astrophys. J.*, v. 380, No. 2, L89–L92. [§ 12.1]
- Lyon J.G.: 2000, The solar wind-magnetosphere-ionosphere system, *Science*, v. 288, No. ?, 1987–1991. [§ 8.2]
- Mackay, D.H., Priest, E.R., Gaizauskas, V., et al.: 1998, Role of helicity in the formation of intermediate filaments, *Solar Phys.*, v. 180, No. 1, 299–312. [§ 13.3]
- Mandrini, C.H. and Machado, M.E.: 1993, Large-scale brightenings associated with flares, *Solar Phys.*, v. 141, No. 1, 147–164. [§ 3.4]
- Mandrini, C.H., Demoulin, P., Hénoux, J.C., et al.: 1991, Evidence for the interaction of large scale magnetic structures in solar flares, *Astron. Astrophys.*, v. 250, No. 2, 541–547. [Intr., § 3.4]
- Mandrini, C.H., Rovira, M.G., Demoulin, P., et al.: 1993, Evidence for reconnection in large-scale structures in solar flares, *Astron. Astrophys.*,

- v. 272, No. 2, 609–620. [Intr., § 3.4]
- Manoharan, P.K., Tokumaru, M., Pick, M., et al.: 2001, Coronal mass ejection of 2000 July 14 flare event: Imaging from near-sun to Earth environment, *Astrophys. J.*, v. 559, No. 2, 1180–1189. [§ 5.2.2]
- Markovskii, S.A. and Somov, B.V.: 1996, A criterion for splitting of a reconnecting current sheet into MHD discontinuities, *J. Plasma Phys.*, v. 55, No. 3, 303–325. [§ 10.2]
- Marsh, G.E.: 1996, *Force-Free Magnetic Fields: Solutions, Topology and Applications*, River Edge, London; World Scientific Publ., p. 159. [§ 12.2]
- Martens, P.C.H.: 1988, The generation of proton beams in two-ribbon flares, *Astrophys. J.*, v. 330, No. 2, L131–L133. [§ 9.3, § 9.4]
- Martin, S.F.: 1986, Recent observations of the formation of filaments, in *Coronal and Prominence Plasmas*, NASA CP-2442, p. 73–80. [§ 5.3, § 13.1]
- Martin, S.F.: 1998, Conditions for the formation and maintenance of filaments, *Solar Phys.*, v. 182, No. 1, 107–137. [§ 5.3, § 13.3]
- Martin, S.F., Livi, S.H.B., and Wang, J.: 1985, The cancellation of magnetic flux. II. In a decaying active region, *Australian J. Phys.*, v. 38, 929–959. [§ 5.3]
- Masuda, S.: 1994, Ph.D. thesis, Univ. Tokyo. [§ 7.2.3]
- Masuda, S.: 2002, Hard X-ray solar flares revealed with Yohkoh HXT - A review, in *Multi-wavelength Observations of Coronal Structure and Dynamics, Yohkoh 10th Anniversary Meeting*, eds P.C.H. Martens and D.P. Cauffman, Amsterdam, Pergamon, p. 351–359. [§ 7.2.1]
- Masuda, S., Kosugi, T., Hara, H., et al.: 1994, A loop-top hard X-ray source in a compact solar flare as evidence for magnetic reconnection, *Nature*, v. 371, 495–497. [Intr., § 7.2.1]
- Masuda, S., Kosugi, T., Hara, H., et al.: 1995, Hard X-ray sources and the primary energy-release site in solar flares, *Publ. Astron. Soc. Japan*, v. 47, 677–689. [Intr.]
- Masuda, S., Kosugi, T., Sakao, T., et al.: 1998, Coronal hard X-ray sources in solar flares observed with Yohkoh/HXT, in *Observational Plasma Astrophysics: Five Years of Yohkoh and Beyond*, eds T. Watanabe, T. Kosugi, and A.C. Sterling, Dordrecht, Kluwer Academic Publ., p. 259–267. [§ 7.2.1]
- Masuda, S., Kosugi, T., and Hudson, H.S.: 2001, A hard X-ray two-ribbon flare observed with Yohkoh/HXT, *Solar Phys.*, v. 204, No. 1, 57–69. [§ 4.1, § 4.2.3, § 4.2.5, § 5.1, § 5.4.1, § 7.5]
- Mathieu, J. and Scott, J.: 2000, *An Introduction to Turbulent Flow*, New York, Cambridge Univ. Press. [§ 12.1.2]

- Mauas, P.J.: 1990, The white-light flare of 1982 June 15 - Observations, *Astrophys. J. Suppl.*, v. 74, 609–646. [§ 13.2.1]
- McKenzie, D.E. and Hudson, H.S.: 1999, X-ray observations of motions and structure above a solar flare arcade, *Astrophys. J.*, v. 519, L93-L96. [§ 7.3.2, § 7.3.5]
- Milano, L.J., Gómez, D.O., and Martens, P.C.H.: 1997, Solar coronal heating: AC versus DC, *Astrophys. J.*, v. 490, No. 1, 442-451. [§ 12.4]
- Miller, J.A. and Reames, D.V.: 1996, Heavy ion acceleration by cascading Alfvén waves in impulsive solar flares, in *High Energy Solar Physics*, eds R. Ramaty, N. Mandzhavidze, and X.-M. Hua, New York, AIP, Woodbury, 450–460. [§ 12.3.2]
- Miller, J.A., LaRosa, T.N., and Moore, R.L.: 1996, Stochastic electron acceleration by cascading fast mode waves in impulsive solar flares, *Astrophys. J.*, v. 461, No. 1, 445–464. [§ 12.3.1]
- Miroshnichenko, L.I.: 2001, *Solar Cosmic Rays*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 480. [Intr., § 9.1]
- Moffatt, H.K.: 1978, *Magnetic Field Generation in Electrically Conducting Fluids*, London, New York, Melbourne; Cambridge Univ. Press, p. 343. [§ 12.1, § 12.5]
- Moiseev, S.S. and Chkhetiani, O.G.: 1996, Helical scaling in turbulence, *JETP*, v. 83, No. 1, 192–198. [§ 12.1]
- Moore, R.L., Falconer, D.A., Porter, J.G., et al.: 1999, On heating the Sun's corona by magnetic explosions: Feasibility in active regions and prospects for quiet regions and coronal holes, *Astrophys. J.*, v. 526, No. 1, 505–522. [§ 12.4]
- Moreton, G.E. and Severny, A.B.: 1968, Magnetic fields and flares, *Solar Phys.*, v. 3, No. 2, 282–297. [§ 3.3]
- Morita, S., Uchida, Y., Hirose, S., et al.: 2001, 3D structure of arcade-type flares derived from the homologous flare series, *Solar Phys.*, v. 200, No. 1, 137–156. [§ 5.1, 6.4]
- Morozov, A.I. and Solov'ev, L.S.: 1966a, The structure of magnetic fields, in: Leontovich M.A. (ed.), *Reviews of Plasma Physics*, New York, Consultants Bureau, v. 2, 1–101. [§ 14.3]
- Mukerjee, K., Agrawal, P., Paul, B., et al.: 2001, Pulse characteristics of the X-ray pulsar 4U1907+09, *Astrophys. J.*, v. 548, No. 1, 368–376. [§ 8.3]
- Murty, G.S.: 1961, Instabilities of a conducting fluid slab carrying uniform current in the presence of a magnetic field, *Ark. Fysik*, v. 19, No. 6, 499–510. [§ 11.1]
- Nagai, T., Fujimoto, M., Saito, Y., et al.: 1998, Structure and dynamics of magnetic reconnection for substorm onsets with Geotail observations, *J. Geophys. Res.*, v. 103, 4419–4428. [Intr., § 11.6]

- Nakar, E., Piran, T., and Sari, R.: 2005, Pure and loaded fireballs in Soft Gamma-Ray repeater giant flares, *Astrophys. J.*, v. 635, No. 1, 516–521. [§ 8.4]
- Nishida, A. and Nagayama, N.: 1973, Synoptic survey for the neutral line in the magnetotail during the substorm expansion phase, *J. Geophys. Res.*, v. 78, No. 19, 3782–3798. [Intr.]
- Nishida, A., Baker, D.N., and Cowley, S.W.H. (eds): 1998, *New Perspectives on the Earth's Magnetotail*, Washington, Amer. Geophys. Un., p. 339. [Intr.]
- Nishikawa, K.I. and Sakai, J.: 1982, Stabilizing effect of a normal magnetic field on the collisional tearing mode, *Phys. Fluids*, v. 25, No. 8, 1384–1387. [§ 11.4]
- Ogawara, Y., Takano, T., Kato, T., et al.: 1991, The Solar-A mission: an overview, *Solar Phys.*, v. 136, No. 1, 1–16. [Intr., § 4.1]
- Ono, Y., Yamada, M., Akao, T., et al.: 1996, Ion acceleration and direct ion heating in three-component magnetic reconnection, *Phys. Rev. Lett.*, v. 76, No. 18, 3328–3331. [§ 6.2, § 7.1]
- Oreshina, A.V. and Somov, B.V.: 1998, Slow and fast magnetic reconnection. I. Role of radiative cooling, *Astron. Astrophys.*, v. 331, 1078–1086. [§ 6.1, § 13.2.3]
- Ott, E.: 1998, Chaotic flows and kinematic magnetic dynamos, *Phys. Plasmas*, v. 5, No. 5, 1636–1646. [§ 12.1]
- Otto, A.: 1991, The resistive tearing instability for generalized resistive models: Theory, *Phys. Fluids*, v. 3B, No. 7, 1739–1745. [§ 11.1]
- Ozernoy, L.M. and Somov, B.V.: 1971, The magnetic field of a rotating cloud and magneto-rotational explosions, *Astrophys. Space Sci.*, v. 11, No. 2, 264–283. [Intr.]
- Paesold, G. and Benz, A.O.: 1999, Electron firehose instability and acceleration of electrons in solar flares, *Astron. Astrophys.*, v. 351, 741–746. [§ 12.3.1]
- Paesold, G., Benz, A.O., Klein, K.-L., et al.: 2001, Spatial analysis of solar type III events associated with narrow band spikes at metric wavelengths, *Astron. Astrophys.*, v. 371, 333–342. [§ 9.4]
- Palmer, I.D. and Smerd, S.F.: 1972, Evidence for a two-component injection of cosmic rays from the solar flare of 1969, March 30, *Solar Phys.*, v. 26, No. 2, 460–467. [§ 9.4]
- Park, B.T., Petrosian, V., and Schwartz, R.A.: 1997, Stochastic acceleration and photon emission in electron-dominated solar flares, *Astrophys. J.*, v. 489, No. 1, 358–366. [§ 12.3.4]
- Parker, E.N.: 1972, Topological dissipation and the small-scale fields in turbulent gases, *Astrophys. J.*, v. 174, No. 1, 499–510. [§ 2.1.2, § 12.1]

- Parker, E.N.: 1979, *Cosmic Magnetic Fields. Their Origin and Their Activity*, Oxford, Clarendon Press, p. 841. [§ 6.1, § 12.1]
- Parker, E.N.: 1988, Nanoflares and the solar X-ray corona, *Astrophys. J.*, v. 330, No. 1, 474–479. [§ 12.1, § 12.4]
- Parker, E.N.: 1993, A solar dynamo surface wave at the interface between convection and nonuniform rotation, *Astrophys. J.*, v. 408, No. 2, 707–719. [§ 12.1]
- Peratt, A.L.: 1992, *Physics of the Plasma Universe*, New York, Berlin, Heidelberg; Springer-Verlag, p. 342. [Intr.]
- Peres, G., Rosner, R., Serio, S., et al.: 1982, Coronal closed structures. 4. Hydrodynamical stability and response to heating perturbations, *Astrophys. J.*, v. 252, No. 2, 791–799. [§ 13.2.3]
- Petrosian, V., Donaghy, T.Q., McTiernan, J.M.: 2002, Loop top hard X-ray emission in solar flares: Images and statistics, *Astrophys. J.*, v. 569, No. 1, 459–473. [§ 7.2.1, § 7.2.3]
- Petschek, H.E.: 1964, Magnetic field annihilation, in *AAS-NASA Symp. on the Physics of Solar Flares*, ed. W.N. Hess, Washington, NASA SP-50, p. 425–439. [§ 10.1, § 10.6]
- Pevtsov, A.A.: 2000, Transequatorial loops in the solar corona, *Astrophys. J.*, v. 531, No. 1, 553–560. [§ 3.4.4]
- Pevtsov, A.A. and Longcope, D.W.: 1998, NOAA 7926: A kinked Ω -loop? *Astrophys. J.*, v. 508, No. 2, 908–915. [§ 3.2]
- Pevtsov, A.A., Canfield, R.C., and Zirin, H.: 1996, Reconnection and helicity in a solar flare, *Astrophys. J.*, v. 473, No. 1, 533–538. [§ 3.2, § 12.2]
- Pike, C.D. and Mason, H.E.: 1998, Rotating transition region features observed with the SOHO CDS, Coronal Diagnostic Spectrometer, *Solar Phys.*, v. 182, No. 2, 333–348. [§ 13.5]
- Pneuman, G.W.: 1974, Magnetic structure responsible for coronal disturbances, in *Coronal Disturbances*, (IAU Symp. 57), ed. G. Newkirk, Dordrecht, Boston; D. Reidel Publ., p. 35–68. [§ 11.1]
- Pneuman, G.W.: 1983, The formation of solar prominences by magnetic reconnection and condensation, *Solar Phys.*, v. 88, No. 2, 219–239. [§ 13.1]
- Podgornii, A.I. and Syrovatskii, S.I.: 1981, Formation and development of a current sheet for various magnetic viscosities and gas pressures, *Soviet J. Plasma Phys.*, v. 7, No. 5, 580–584. [§ 10.1, § 10.5]
- Pollard, R.K. and Taylor, Y.B.: 1979, Influence of equilibrium flows on tearing modes, *Phys. Fluids*, v. 22, No. 1, 126–131. [§ 11.5]
- Pope, S.B.: 2000, *Turbulent Flows*, Cambridge, UK; Cambridge Univ. Press. [§ 12.1.2]

- Porter, L.J., Klimchuk, J.A., and Sturrock, P.A.: 1992, Cylindrically symmetric force-free magnetic fields, *Astrophys. J.*, v. 385, No. 2, 738–745. [§ 14.2]
- Priest, E.R.: 1982, *Solar Magnetohydrodynamics*, Dordrecht, Boston, London; D. Reidel Publ. Co., p. 472. [§ 12.4, § 14.2]
- Priest, E.R. and Forbes, T.: 2000, *Magnetic Reconnection: MHD Theory and Applications*, Cambridge, Cambridge Univ. Press. [Intr.]
- Priest, E.R., Titov, V.S., Vekstein, G.E., et al.: 1994, Steady linear X-point magnetic reconnection, *J. Geophys. Res.*, v. 99, No. A11, 21467–21479. [§ 13.2.3]
- Qiu, J., Lee, J., and Gary, D.E.: 2004, Impulsive and gradual nonthermal emissions in an X-class flare, *Astrophys. J.*, v. 603, No. 1, 335–347. [4.2.5, 7.5]
- Raadu, M.A.: 1984, Global effects of double layers, in *Second Symp. on Plasma Double Layers and Related Topics*, eds R. Schrittwieser and G. Eder; Innsbruck, p. 3–27. [§ 14.2]
- Ranns, N.D.R., Harra, L.K., Matthews, S.A., et al.: 2000, Emerging flux as a driver for homologous flares, *Astron. Astrophys.*, v. 360, 1163–1169. [§ 3.4]
- Reiman, A.: 1980, Minimum energy state of a toroidal discharge, *Phys. Fluids*, v. 23, No. 1, 230–231. [§ 12.5]
- Roald, C.B., Sturrock, P.A., and Wolfson, R.: 2000, Coronal heating: Energy release associated with chromospheric magnetic reconnection, *Astrophys. J.*, v. 538, No. 2, 960–967. [§ 12.4]
- Roikhvarger, Z.B. and Syrovatskii, S.I.: 1974, Evolutionarity of MHD discontinuities with allowance for dissipative waves, *Soviet Physics–JETP*, v. 39, No. 4, 654–656. [§ 10.2]
- Romanova, M.M., Ustyugova, G.V., Koldoba, A.V., et al.: 2004, Three-dimensional simulations of disk accretion to an inclined dipole. II. Hot spots and variability, *Astrophys. J.*, v. 610, No. 2, 929–932. [§ 8.3]
- Rose, W.K.: 1998, *Advanced Stellar Astrophysics*, Cambridge, Cambridge Univ. Press, p. 494. [Intr.]
- Roumeliotis, G. and Moore, R.L.: 1993, A linear solution for magnetic reconnection driven by converging or diverging footpoint motions, *Astrophys. J.*, v. 416, No. 1, 386–391. [§ 13.1]
- Rust, D.M. and Kumar, A.: 1996, Evidence for helically kinked magnetic flux ropes in solar eruptions, *Astrophys. J.*, v. 464, No. 2, L199–L202. [§ 3.2]
- Sakai, J.I. and de Jager, C.: 1996, Solar flares and collisions between current-carrying loops, *Space Sci. Rev.*, v. 77, No. 1, 1–192. [§ 3.2, § 14.2]
- Sakao, T.: 1994, PhD Thesis, The University of Tokyo. [§ 5.4.2]

- Sakao, T., Kosugi, T., and Masuda, S.: 1998, Energy release in solar flares with respect to magnetic loops, in *Observational Plasma Astrophysics: Five Years of Yohkoh and Beyond*, eds T. Watanabe, T. Kosugi, and A.C. Sterling, Dordrecht, Kluwer Academic Publ., p. 273-284. [§ 3.4, § 4.1, § 5.4.2]
- Sato, J.: 1997, PhD thesis, Graduate University of Advanced Science, Tokyo. [§ 7.2.1]
- Sato, J.: 2001, Observation of the coronal hard X-ray sources of the 1998 April 23 flare, *Astrophys. J.*, v. 558, L137–L140. [§ 7.2.1]
- Sato, J., Kosugi, T., Makishima, K.: 1999, Improvement of Yohkoh hard X-ray imaging, *Publ. Astron. Soc. Japan*, v. 51, 127–150. [§ 7.2.1, § 7.2.2]
- Sato, J., Sawa, M., Yoshimura, K., et al.: 2003, *The Yohkoh HXT/SXT Flare Catalogue*, Montana, Montana State Univ.; Sagamihara, Inst. of Space and Astronautical Science. [§ 7.2.3]
- Schabansky, V.P.: 1971, Some processes in the magnetosphere, *Space Sci. Rev.*, v. 12, No. 3, 299–418. [§ 9.3]
- Scherrer, P.H., Bogart, R.S., Bush, R.I., et al.: 1995, The solar oscillations investigation - Michelson Doppler Imager, *Solar Phys.*, v. 162, No. 1, 129–188. [Intr., § 4.1]
- Schindler, K.: 1974, A theory of the substorm mechanism, *J. Geophys. Res.*, v. 79, No. 19, 2803–2810. [§ 11.1, § 11.6]
- Schrijver, C.J., DeRosa M.L., Title, A.M., et al.: 2005, The nonpotentiality of active-region coronae and the dynamics of the photospheric magnetic field, *Astrophys. J.*, v. 628, No. 1, 501–513. [§ 3.3.3, § 5.2.3]
- Schrijver, C.J., Title, A.M., van Ballegooijen, A.A., et al.: 1997, Sustaining the quiet photospheric network: The balance of flux emergence, fragmentation, merging, and cancellation, *Astrophys. J.*, v. 487, No. 1, 424–436. [§ 12.4]
- Schuster, H.G.: 1984, *Deterministic Chaos. An Introduction*, Weinheim, Physik-Verlag, p. 220. [§ 9.2]
- Severny, A.B.: 1962, The stability of plasma layer with a neutral-point magnetic field, *Soviet Astronomy-AJ*, v. 6, No. 6, 770–773. [§ 2.1]
- Severny, A.B.: 1964, Solar flares, *Ann. Rev. Astron. Astrophys.*, v. 2, 363–400. [§ 3.1]
- Shafranov, V.D.: 1966, Plasma equilibrium in a magnetic field, in *Reviews of Plasma Physics*, ed. M.A. Leontovich, New York, Consultants Bureau, v. 2, 103–151. [§ 14.3]
- Share, G.H., Murphy, R.J., Tulka, A.J., et al.: 2001, Gamma-ray line observations of the 2000 July 14 flare and SEP impact on the Earth, *Solar Phys.*, v. 204, No. 1, 43–55. [§ 5.1]

- Sheeley, N.R.Jr., Bohling, J.D., Brueckner, G.E., et al.: 1975, XUV observations of coronal magnetic fields, *Solar Phys.*, v. 40, No. 1, 103–121. [§ 3.4.4]
- Shibasaki, K.: 2001, High-beta disruption in the solar atmosphere, *Astrophys. J.*, v. 557, No. 1, 326–331. [§ 5.5]
- Shibata, K., Masuda, S., Shimojo, M., et al.: 1995, Hot-plasma ejections associated with compact-loop solar flares, *Astrophys. J.*, v. 451, Part 2, L83–L86. [§ 5.1]
- Simnett, G.M.: 2000, Studies of the dynamic corona from SOHO, in *High Energy Solar Physics: Anticipating HESSI*, eds R. Ramaty and N. Mandzhavidze, Greenbelt, Maryland, ASP Conference Series, v. 206, 43–53. [§ 7.3]
- Sitnov, M.I. and Sharma, A.S.: 1998, Role of transient electrons and microinstabilities in the tearing instability of the geomagnetotail current sheet, and the general scenario of the substorms as a catastrophe, in *Substorms-4*, eds S. Kokubun and Y. Kamide, Dordrecht, Kluwer Academic Publ.; Tokyo, Terra Sci. Publ., p. 539–542. [§ 11.6]
- Sitnov, M.I., Malova, H.V., and Lui, A.T.Y.: 1997, Quasi-neutral sheet tearing instability induced by electron preferential acceleration from stochasticity, *J. Geophys. Res.*, v. 102, No. A1, 163–173. [§ 11.6]
- Somov, B.V.: 1981, Fast reconnection and transient phenomena with particle acceleration in the solar corona, *Bull. Acad. Sci. USSR, Phys. Ser.*, v. 45, No. 4, 114–116. [§ 6.1, § 8.1, § 9.4.2]
- Somov, B.V.: 1985, New theoretical models of solar flares, *Soviet Phys. Usp.*, v. 28, No. 3, 271–272. [§ 3.2, § 6.4, § 14.3]
- Somov, B.V.: 1986, Non-neutral current sheets and solar flare energetics, *Astron. Astrophys.*, v. 163, No. 1, 210–218. [§ 3.2, § 6.4]
- Somov, B.V.: 1991, A scenario for the large-scale magnetic field evolution in CMEs, *Journal of Geomag. and Geoelectricity*, v. 43 (Suppl.), 31–36. [§ 7.3]
- Somov, B.V.: 1992, *Physical Processes in Solar Flares*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 248. [§ 3.2, § 4.1, § 6.2, § 6.3, § 7.1, § 8.1, § 9.1, § 9.2, § 9.3, § 10.1, § 11.5, § 11.6, § 14.2]
- Somov, B.V.: 1999, Cosmic electrodynamics and solar physics, *Bull. Russ. Acad. Sci., Physics*, v. 63, No. 8, 1157–1162. [§ 12.4]
- Somov, B.V.: 2000, *Cosmic Plasma Physics*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 652. [Intr., § 6.4]
- Somov, B.V. and Bogachev, S.A.: 2003, The betatron effect in collapsing magnetic trap. *Astronomy Lett.*, v. 29, 621–628. [§ 7.4.1, § 7.4.2, § 7.4.3, § 7.4.4]
- Somov, B.V. and Hénoux J.C.: 1999, Generation and interaction of electric currents in the quiet photospheric network, in *Magnetic Fields and Solar*

- Processes*, Proc. 9th European Meeting on Solar Physics, ESA SP-448, 659–663. [§ 12.4, § 14.2]
- Somov, B.V. and Kosugi, T.: 1997, Collisionless reconnection and high-energy particle acceleration in solar flares, *Astrophys. J.*, v. 485, No. 2, 859–868. [§ 4.1, § 4.2.5, § 6.4, § 7.3, § 7.5, § 7.6, § 8.1]
- Somov, B.V. and Kozlova, L.M.: 1998, Fine structure of the solar chromosphere from infrared He I line observations, *Astronomy Reports*, v. 42, No. 6, 819–826. [§ 13.5]
- Somov, B.V. and Litvinenko, Yu.E.: 1993, Magnetic reconnection and particle acceleration in the solar corona, in *Physics of Solar and Stellar Coronae*, eds J. Linsky and S. Serio, Dordrecht, Kluwer Academic Publ., p. 603–606. [§ 9.1]
- Somov, B.V. and Merenkova, E.Yu.: 1999, Model computations of magnetic fields in solar flares, *Bull. Russ. Acad. Sci., Physics*, v. 63, No. 8, 1186–1188. [§ 3.4, § 9.2, § 14.3]
- Somov, B.V. and Oreshina, A.V.: 2000, Slow and fast magnetic reconnection. II. High-temperature turbulent-current sheet, *Astron. Astrophys.*, v. 354, 703–713. [§ 6.1, § 6.3]
- Somov, B.V. and Syrovatskii, S.I.: 1972, Appearance of a current sheet in a plasma moving in the field of a two-dimensional magnetic dipole, *Soviet Phys.-JETP*, v. 34, No. 5, 992–997. [§ 2.1.2, § 6.1, § 8.3, § 14.3]
- Somov, B.V. and Syrovatskii, S.I.: 1975, Electric and magnetic fields arising from the rupture of a neutral current sheet. *Bull. Acad. Sci. USSR, Phys. Series*, v. 39, No. 2, 109–111. [§ 3.3]
- Somov, B.V. and Syrovatskii, S.I.: 1976a, Physical processes in the solar atmosphere associated with flares, *Soviet Physics Usp.*, v. 19, No. 10, 813–835. [§ 6.1]
- Somov, B.V. and Syrovatskii, S.I.: 1976b, Hydrodynamic plasma flows in a strong magnetic field, in *Neutral Current Sheets in Plasma*, Proc. P.N. Lebedev Phys. Inst., v. 74, ed. N.G. Basov, New York and London, Consultants Bureau, p. 13–71. [§ 2.2, § 10.1]
- Somov, B.V. and Syrovatskii, S.I.: 1977, Current sheets as the source of heating for solar active regions, *Solar Phys.*, v. 55, No. 2, 393–399. [§ 3.3]
- Somov, B.V. and Syrovatskii, S.I.: 1982, Thermal trigger for solar flares and coronal loops formation, *Solar Phys.*, v. 75, No. 1, 237–244. [§ 6.1]
- Somov, B.V. and Titov, V.S.: 1983, Magnetic reconnection as a mechanism for heating the coronal loops, *Soviet Astronomy Letters*, v. 9, No. 1, 26–28. [§ 8.1]
- Somov, B.V. and Titov, V.S.: 1985a, Effect of longitudinal magnetic field in current sheets on the Sun, *Soviet Astronomy-AJ*, v. 29, No. 5, 559–563. [§ 6.2, § 12.2]

- Somov, B.V. and Titov, V.S.: 1985b, Magnetic reconnection in a high-temperature plasma of solar flares. 2. Effects caused by transverse and longitudinal magnetic fields. *Solar Phys.*, v. 102, No. 1, 79–96. [§ 6.2, § 11.5, § 12.2]
- Somov, B.V. and Verneta, A.I.: 1988, Magnetic reconnection in a high-temperature plasma of solar flares. 3. Stabilization effect of a transverse magnetic field in non-neutral current sheets, *Solar Phys.*, v. 117, No. 1, 89–95. [§ 11.1, § 11.6]
- Somov, B.V. and Verneta, A.I.: 1989, Magnetic reconnection in a high-temperature plasma of solar flares. 4. Resistive tearing mode in non-neutral current sheets, *Solar Phys.*, v. 120, No. 1, 93–115. [§ 11.1, § 11.4]
- Somov, B.V. and Verneta, A.I.: 1993, Tearing instability of reconnecting current sheets in space plasmas, *Space Sci. Rev.*, v. 65, No. 3, 253–288. [§ 11.1, § 11.5, § 11.6]
- Somov, B.V., Kosugi, T., and Sakao, T.: 1998, Collisionless 3D reconnection in impulsive solar flares. *Astrophys. J.*, v. 497, No. 2, 943–956. [§ 3.4, § 4.1, § 5.1.2, § 5.2.3, § 5.4.1, § 5.5, § 6.4, § 8.1, § 9.2]
- Somov, B.V., Litvinenko, Y.E., Kosugi, T., et al.: 1999, Coronal hard X-rays in solar flares: *Yohkoh* observations and interpretation, in *Magnetic Fields and Solar Processes*, Proc. 9th European Meeting on Solar Physics, ESA SP-448, 701–708. [§ 7.3, § 7.6]
- Somov, B.V., Kosugi, T., Litvinenko, Y.E., et al.: 2001, Collisionless reconnection in the structure and dynamics of active regions, in *Recent Insight into the Physics of the Sun and Heliosphere: Highlights from SOHO and Other Space Missions*, Proc. IAU Symp. 203, eds P. Brekke, B. Fleck, and J.B. Gurman; Chelsea, Sheridan Books, 558–561. [§ 3.2, § 14.3]
- Somov, B.V., Kosugi, T., Hudson, H.S., et al.: 2002a, Magnetic reconnection scenario of the Bastille day 2000 flare, *Astrophys. J.*, v. 579, No. 2, 863–873. [§ 4.1, § 5.2.3, § 5.4.1, § 5.4.4, § 5.5, § 6.4, § 12.2]
- Somov, B.V., Kosugi, T., Litvinenko, Y.E., et al.: 2002b, Three-dimensional reconnection at the Sun: Space observations and collisionless models, *Adv. Space Res.*, v. 29, No. 7, 1035–1044. [§ 3.2]
- Somov, B.V., Hénoux, J.C., and Bogachev, S.A.: 2002c, Is it possible to accelerate ions in collapsing magnetic trap? *Adv. Space Res.*, v. 30, No. 1, 55–60. [§ 7.6]
- Somov, B.V., Oreshina, A.V., Oreshina, I.V., et al.: 2003a, Flares in accretion disk coronae, *Adv. Space Res.*, v. 32, No. 6, 1087–1096. [Intr., § 8.3]
- Somov, B.V., Kosugi, T., Hudson, H.S., et al.: 2003b, Modeling large solar flares, *Adv. Space Res.*, v. 32, No. 12, 2439–2450. [§ 5.4.4]

- Somov, B.V., Kosugi, T., Bogachev, S.A., et al.: 2005a, Motion of the HXR sources in solar flares: *Yohkoh* images and statistics, *Adv. Space Res.*, v. 35, No. 10, 1700–1706. [5.4.2]
- Somov, B.V., Kosugi, T., Bogachev, S.A., et al.: 2005b, On upward motions of coronal hard X-ray sources in solar flares, *Adv. Space Res.*, v. 35, No. 10, 1690–1699. [7.2.3]
- Somov, B.V., Kosugi, T., Oreshina, I.V., et al.: 2005c, Large-scale reconnection in a large flare, *Adv. Space Res.*, v. 35, No. 10, 1712–1722. [4.2.5]
- Sotirelis, T. and Meng, C.-I.: 1999, Magnetopause from pressure balance, *J. Geophys. Res.*, v. 104, No. A4, 6889–6898. [§ 8.2]
- Speiser, T.W.: 1965, Particle trajectories in model current sheets. 1. Analytical solutions, *J. Geophys. Res.*, v. 70, No. 17, 4219–4226. [§ 1.2, § 9.1, § 9.2, § 9.3, § 9.4]
- Speiser, T.W.: 1968, On the uncoupling of parallel and perpendicular particle motion in a neutral sheet, *J. Geophys. Res.*, v. 73, No. 3, 1112–1113. [§ 9.2]
- Speiser, T.W. and Lyons, L.R.: 1984, Comparison of an analytical approximation for particle motion in a current sheet with precise numerical calculations, *J. Geophys. Res.*, v. 89, No. A1, 147–158. [§ 9.3]
- Spicer, D.S.: 1982, Magnetic energy storage and conversion in the solar atmosphere, *Space Sci. Rev.*, v. 31, No. 1, 351–435. [§ 3.3, § 14.4]
- Stenzel, R.L. and Gekelman, W.: 1984, Particle acceleration during reconnection in laboratory plasmas. *Adv. Space Res.*, v. 4, No. 2, 459–470. [§ 3.3, § 14.2]
- Sterling, A.C. and Hudson, H.S.: 1997, *Yohkoh* SXT observations of X-ray “dimming” associated with a halo coronal mass ejection, *Astrophys. J.*, v. 491, No. 1, L55–L58. [§ 3.2]
- Stewart, R.T. and Labrum, N.R.: 1972, Meter-wavelength observations of the solar radio storm of August 17–22, 1968. *Solar Phys.*, v. 27, No. 1, 192–202. [§ 9.4]
- Strong, K.T., Saba, J.L.R., Haisch, B.M., et al. (eds): 1999, *The Many Faces of the Sun*, New York, Berlin, Heidelberg, Tokyo; Springer, p. 610. [Intr., § 4.1]
- Sturrock, P.A.: 1991, Maximum energy of semi-infinite magnetic field configurations, *Astrophys. J.*, v. 380, No. 2, 655–659. [§ 14.2]
- Sturrock, P.A.: 1994, *Plasma Physics: An Introduction to the Theory of Astrophysical, Geophysical and Laboratory Plasmas*, Cambridge, Cambridge Univ. Press, p. 335. [Intr.]
- Sudol, J.J. and Harvey, J.W.: 2005, Longitudinal magnetic field changes accompanying solar flares, *Astrophys. J.*, v. 635, No. 1, 647–658. [§ 3.1.1, § 3.1.3]

- Sui, L. and Holman, G.D.: 2003, Evidence for the formation of a large-scale current sheet in a solar flare, *Astrophys. J.*, v. 596, L251–L254. [§ 7.2.2, § 7.2.3]
- Sui, L., Holman, G.D., and Dennis, B.R.: 2004, Evidence for magnetic reconnection in three homologous solar flares observed by RHESSI, *Astrophys. J.*, v. 612, No. 1, 546–556. [§ 7.2.2, § 7.2.3]
- Svestka, Z.: 1976, *Solar Flares*, Dordrecht, D. Reidel Publ. [§ 4.1, § 5.1, § 5.4.3]
- Sweet, P.A.: 1958, The production of high energy particles in solar flares, *Nuovo Cimento Suppl.*, v. 8, Serie 10, 188–196. [Intr., § 14.2]
- Sweet, P.A.: 1969, Mechanisms of solar flares, *Ann. Rev. Astron. Astrophys.*, v. 7, 149–176. [§ 2.1, § 3.2, § 6.1, § 9.1]
- Syrovatskii, S.I.: 1956, Some properties of discontinuity surfaces in MHD, *Proc. P.N. Lebedev Phys. Inst.*, v. 8, 13–64 (in Russian). [§ 10.3]
- Syrovatskii, S.I.: 1962, The stability of plasma in a nonuniform magnetic field and the mechanism of solar flares, *Soviet Astronomy–AJ*, v. 6, No. 6, 768–769. [§ 2.1]
- Syrovatskii, S.I.: 1966a, Dynamic dissipation of a magnetic field and particle acceleration, *Soviet Astronomy–AJ*, v. 10, No. 2, 270–276. [§ 2.1, § 2.2, § 2.3, § 3.2, § 3.4, § 6.4, § 7.1, § 14.3]
- Syrovatskii, S.I.: 1966b, Dynamical dissipation of magnetic energy in the vicinity of a neutral line, *Soviet Physics–JETP*, v. 23, No. 4, 754–762. [§ 2.1, § 2.3, § 6.4]
- Syrovatskii, S.I.: 1968, MHD cumulation near a zero field line, *Soviet Physics–JETP*, v. 27, No. 5, 763–766. [§ 2.4]
- Syrovatskii, S.I.: 1971, Formation of current sheets in a plasma with a frozen-in strong field, *Soviet Physics–JETP*, v. 33, No. 5, 933–940. [§ 10.1, § 14.3]
- Syrovatskii, S.I.: 1972, Particle acceleration and plasma ejection from the Sun, in *Solar-Terrestrial Physics 1970, Part 1*, ed. E.R. Dryer, Dordrecht, D. Reidel Publ., 119–133. [§ 3.4.1, § 5.1.1]
- Syrovatskii, S.I.: 1976a, Neutral current sheets in laboratory and space plasmas, in *Neutral Current Sheets in Plasmas*, Proc. P.N. Lebedev Phys. Inst., v. 74, ed. N.G. Basov, New York, London; Consultants Bureau, p. 2–10. [§ 6.1, § 10.1]
- Syrovatskii, S.I.: 1976b, Current-sheet parameters and a thermal trigger for solar flares, *Soviet Astron. Lett.*, v. 2, No. 1, 13–14. [§ 3.3, § 6.1] v2, 3.3.1, 5.1.2
- Syrovatskii, S.I.: 1981, Pinch sheets and reconnection in astrophysics, *Ann. Rev. Astron. Astrophys.*, v. 19, 163–229. [§ 3.2, § 3.3, § 3.4, § 6.1, § 9.1, § 9.4, § 11.5, § 14.2]

- Syrovatskii, S.I.: 1982, Model for flare loops, fast motions, and opening of magnetic field in the corona, *Solar Phys.*, v. 76, No. 1, 3–20. [§ 3.2, § 9.1, § 13.1]
- Syrovatskii, S.I. and Somov, B.V.: 1980, Physical driving forces and models of coronal responses, in *Solar and Interplanetary Dynamics*, eds M. Dryer and E. Tandberg-Hanssen, IAU Symp. **91**, Dordrecht, Reidel, p. 425–441. [§ 3.2, § 14.2]
- Tanaka, K.: 1987, Impact of X-ray observations from the Hinitori satellite on solar flare research, *Publ. Astron. Soc. Japan*, v. 39, No. 1, 1–45. [§ 7.1]
- Tandberg-Hanssen, E.: 1995, *The Nature of Solar Prominences*, Dordrecht, Boston, London; Kluwer Academic Publ., p. 308. [§ 13.1]
- Taylor, J.B.: 1974, Relaxation of toroidal plasma and generation of reverse magnetic fields. *Phys. Rev. Lett.*, v. 33, No. 19, 1139–1141. [§ 12.1, § 12.2.2]
- Taylor, J.B.: 1986, Relaxation and magnetic reconnection in plasmas, *Rev. Mod. Phys.*, v. 58, No. 3, 741–763. [§ 12.1]
- Tian, L., Wang, J., and Wu, D.: 2002, Non-potentiality of the magnetic field beneath the eruptive filament in the Bastille event. *Solar Phys.*, v. 209, 375–389. [4.2.4]
- Titov, V.S., Priest, E.R., and Démoulin, P.: 1993, Conditions for the appearance of ‘bald patches’ at the solar surface, *Astron. Astrophys.*, v. 276, No. 2, 564–570. [§ 14.3]
- Tsuneta, S.: 1993, Solar flares as an ongoing magnetic reconnection process, in *ASP Conf. Series*, v. 46, eds H. Zirin, G. Ai, and H. Wang, p. 239–248. [Intr., § 14.2]
- Tsuneta, S.: 1996, Structure and dynamics of reconnection in a solar flare, *Astrophys. J.*, v. 456, No. 2, 840–849. [§ 4.1, § 5.1, § 6.1, § 6.4, § 7.1]
- Tsuneta, S. and Naito, T.: 1996, Fermi acceleration at the fast shock in a solar flare and the impulsive loop-top hard X-ray source. *Astrophys. J.* v. 495, L67-L70. [7.4.1]
- Tsuneta, S., Nitta, N., Ohki, K., et al.: 1984, Hard X-ray imaging observations of solar hot thermal flares with the *Hinotori* spacecraft, *Astrophys. J.*, v. 284, No. 2, 827–832. [§ 7.1]
- Tsuneta, S., Acton, L., Bruner, M., et al.: 1991, The soft X-ray telescope for the Solar-A mission, *Solar Phys.*, v. 136, No. 1, 37–67. [Intr., § 4.1]
- Tsuneta, S., Hara, H., Shimuzu, T., et al.: 1992, Observation of a solar flare at the limb with the Yohkoh soft X-ray telescope, *Publ. Astron. Soc. Japan*, v. 44, No. 5, L63–L69. [Intr.]
- Tsuneta, S., Masuda, S., Kosugi, T., et al.: 1997, Hot and super-hot plasmas above an impulsive-flare loop, *Astrophys. J.*, v. 478, No. 2, 787–796. [§ 4.1, § 6.1, § 6.4, § 7.1, § 7.3]

- Tsurutani, B.T., Gonzalez, W.D., Kamide, Y., et al. (eds): 1997, *Magnetic Storms*, Washington, Amer. Geophys. Un., p. 266. [Intr.]
- Tsyganenko, N.A.: 1996, Effects of the solar wind conditions on the global magnetospheric configuration as deduced from data-based field models, in *Proc. of 3rd International Conf. on Substorms (ICS-3)*, Eur. Space Agency Publ., ESA SP-389, p. 181–190. [§ 8.2]
- Uchida, Y., Hirose, S., Morita, S., et al.: 1998, Observations of flares and active regions from Yohkoh, and magnetohydrodynamic models explaining them, *Astrophys. Space Sci.*, v. 264, No. 1, 145–169. [§ 5.1, § 5.5]
- Ulmschneider, P., Rosner, R., and Priest, E.R. (eds): 1991, *Mechanisms of Chromospheric and Coronal Heating*, Berlin, Springer-Verlag. [§ 12.4]
- van Ballegooijen, A.A. and Martens, P.C.H.: 1989, Formation and eruption of solar prominences, *Astrophys. J.*, v. 343, No. 3, 971–984. [§ 5.3, § 13.1]
- van Ballegooijen, A.A. and Martens, P.C.H.: 1990, Magnetic fields in quiescent prominences, *Astrophys. J.*, v. 361, No. 1, 283–289. [§ 13.1]
- Vekstein, G.E. and Priest, E.R.: 1992, Magnetohydrodynamic equilibria and cusp formation at an X-type neutral line by footpoint shearing, *Astrophys. J.*, v. 384, No. 1, 333–340. [§ 14.2, § 14.3]
- Vernazza, J.E., Avrett, E.H., and Loeser, R.: 1981, Structure of the solar chromosphere. 3. Models of the EUV brightness components of the quiet Sun, *Astrophys. J. Suppl.*, v. 45, 635–725. [§ 13.2.2]
- Verneta, A.I. and Somov, B.V.: 1993, Effect of compressibility on the development of the tearing instability in a non-neutral current sheet in the solar atmosphere, *Astronomy Reports*, v. 37, No. 3, 282–285. [§ 11.5]
- Vladimirov, V.S.: 1971, *Equations of Mathematical Physics*, New York, M. Dekker, p. 418. [§ 11.6]
- Wang, H. and Qiu, J.: 2002, Relationship between flare kernels in H α far-blue wing and magnetic fields, *Astrophys. J.*, v. 568, No. 1, 408–412. [§ 4.1]
- Wang, H., Liu, C., Deng, Y., et al.: 2005, Reevaluation of the magnetic structure and evolution associated with the Bastille day flare on 2000 July 14, *Astrophys. J.*, v. 627, No. 2, 1031–1039. [§ 3.1.1, § 3.1.3, § 5.1.1]
- Wang, H., Qiu, J., Jing, J., et al.: 2003, Study of ribbon separation of a flare associated with a quiescent filament eruption, *Astrophys. J.*, v. 593, No. 1, 564–570. [5.4.5]
- Wang, J.: 1999, Vector magnetic fields and magnetic activity of the Sun, *Fundamen. Cosmic Phys.*, v. 20, No. 3, 251–382. [§ 3.1, § 13.3]
- Wang, J. and Shi, Z.: 1993, The flare-associated magnetic changes in an active region. II. Flux emergence and cancelation, *Solar Phys.*, v. 143, No. 1, 119–139. [§ 4.2.4, § 5.5]

- Wang, J.X., Shi, Z.X., Wang, H., et al.: 1996, Flares and the magnetic non-potentiality, *Astrophys. J.*, v. 456, No. 2, 861–878. [§ 3.3]
- Wang, Y.-M. and Sheeley, N.R.: 2002, Observations of core fallback during Coronal Mass Ejections, *Astrophys. J.*, v. 567, No. 2, 1211–1224. [7.3.5]
- Woltjer, L.: 1958, A theorem on force-free magnetic fields, *Proc. Nat. Acad. Sci. USA*, v. 44, No. 6, 489–491. [§ 12.1]
- Woltjer, L.: 1959, Hydromagnetic equilibrium: II. Stability in the variational formulation, *Proc. Nat. Acad. Sci. USA*, v. 45, No. 6, 769–771. [§ 12.5]
- Wright, A.N. and Berger, M.A.: 1989, The effect of reconnection upon the linkage and interior structure of magnetic flux tubes, *J. Geophys. Res.*, v. 94, No. A2, 1295–1302. [§ 12.1]
- Wright, A.N. and Berger, M.A.: 1991, A physical description of magnetic helicity evolution in the presence of reconnection lines, *J. Plasma Phys.*, v. 46, No. 1, 179–199. [§ 12.2]
- Wright, J.M.: 1997, *National Space Weather Program: The Implementation Plan*, Washington, D.C., Off. Fed. Coord. Meteorol. Serv. Supp. Res., FCM-P31. [Intr., § 8.2]
- Yan, Y., Deng, Y., Karlicky, M., et al.: 2001, The magnetic rope structure and associated energetic processes in the 2000 July 14 solar flare, *Astrophys. J.*, v. 551, Part 2, L115–L118. [§ 4.1, § 5.2.3]
- Zel'dovich, Ya.B. and Raizer, Yu.P.: 1966, *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*, New York, San Francisco, London; Academic Press, v. 1, p. 464; v. 2, p. 452. [§ 2.4]
- Zel'dovich, Ya.B. and Raizer, Yu.P.: 2002, *Physics of Shock Waves and High-Temperature Hydrodynamic Phenomena*, eds W.D. Hayes and R.F. Probst, Mineola, Dover. [§ 2.4]
- Zhang, H.: 1995, Configuration of magnetic shear and vertical current in the active region NOAA 5395 in 1989 March, *Astron. Astrophys. Suppl.*, v. 111, No. 1, 27–40. [§ 3.3]
- Zhang, H.: 2002, Magnetic field, helicity and the 2000 July 14 flare in solar active region 9077, *Mon. Not. Royal Astron. Soc.*, v. 332, No. 2, 500–512. [§ 4.2.4, § 5.1]
- Zhang, H.-Q. and Chupp, E. L.: 1989, Studies on post-flare prominence of 1981 April 27, *Astrophys. Space Sci.*, v. 153, No. 1, 95–108. [§ 9.4]
- Zhang, J., Wang, J., Deng, Y., et al.: 2001, Magnetic flux cancellation associated with the major solar event on 2000 July 14, *Astrophys. J.*, v. 548, Part 2, L99–L102. [§ 4.1, § 5.2.2, § 5.3]
- Zirin, H.: 1988, *Astrophysics of the Sun*, Dordrecht, D. Reidel. [§ 4.1, § 5.1]
- Zirker, J.B. and Cleveland, F.M.: 1993, Avalanche models of active region heating and flaring, *Solar Phys.*, v. 145, No. 1, 119–128. [§ 12.1]

- Zuccarello, F., Burm, H., Kuperus, M., et al.: 1987, Varying self-inductance and energy storage in a sheared force-free arcade, *Astron. Astrophys.*, v. 180, No. 1, 218–222. [§ 14.4]
- Zweibel, E.G.: 1989, Magnetic reconnection in partially ionized gases, *Astrophys. J.*, v. 340, No. 2, 550–557. [§ 13.2.3]
- Zwingmann, W., Schindler, K., and Birn, J.: 1985, On sheared magnetic field structures containing neutral points, *Solar Phys.*, v. 99, No. 1, 133–143. [§ 11.1, § 14.2, § 14.3]

Index

- abundance
 - elements, 328, 332
- acceleration
 - by electric field, 19, 38, 45, 131, 234
 - by Langmuir turbulence, 235
 - by shock waves, 232
 - electric field, 342
 - electrons, 19, 211, 217, 223, 224, 307, 311
 - Fermi, 172, 307
 - in current layer, 18, 38, 211
 - in solar flares, 224, 232
 - ions, 19, 168, 226
 - particle, 1, 38, 212
 - regular, 38, 224
 - stochastic, 224, 307
- accretion disk, 1
- active galaxy, 1
- active region, 3, 6, 243, 297
- adiabatic invariant
 - second *or* longitudinal, 172
- alpha-effect, 300, 302
- approximation
 - adiabatic *or* drift, 9, 219
 - collisionless, 288
 - force free, 350
 - ideal MHD, 27
 - large mag. Reynolds number, 299
 - line tying, 345
 - magnetostatic, 243
 - non-relativistic, 16
 - one-fluid, 321, 329
 - small mag. Reynolds number, 304, 323
 - stationary, 321
 - strong magnetic field, 22, 141, 154
 - strong-field-cold-plasma, 23, 30
 - three-fluid, 329
 - two-dimensional, 346
 - WKB, 244, 257, 294
- atmosphere
 - solar, 5, 19
- bald patch, 354
- bifurcation, 63, 237, 294
- black hole, 236
- boundary conditions
 - on current layer, 260
- boundary layer, 345
- catastrophe theory, 294
- chirality, 327, 343
- collapse
 - magnetic, 44
- collapsing magnetic trap, 235
- collision
 - between neutrals and ions, 325
- conditions
 - initial, 24
- conductivity
 - electric, 270, 322
 - Hall, 343
 - perpendicular, 343

- conservation law
 - magnetic flux, 350
 - magnetic helicity, 299
- continuity equation
 - for plasma, 31
 - Lagrangian form, 31
- cooling
 - radiative, 319
- coordinates
 - generalized, 220
 - Lagrangian, 31
- Coriolis force, 305
- coronal heating, 297, 304, 313
- coronal mass ejection, 2, 5, 62, 170, 201, 227, 232, 344
- coronal transient, 2, 5, 62, 235, 344
- cosmic rays, 236
- cumulative effect, 22, 29, 38
- current
 - conductive, 36
 - direct, 9
 - displacement, 36
 - field-aligned, 339
 - interruption, 340
 - reverse, 9, 34, 241
- current layer
 - energy, 54
 - evolutionarity, 265
 - formation, 54
 - interplanetary, 136
 - neutral, 19, 25, 129, 270, 285, 324
 - non-adiabatic thickness, 219
 - non-neutral, 136, 271
 - electrically, 19, 228
 - magnetically, 19, 212, 223
 - reconnecting, 9, 24, 237, 269
 - splitting, 237
 - super-hot turbulent-current, 168, 211
- density
 - change, 31
 - magnetic field energy, 169
- differential rotation, 303
- diffusion
 - turbulent, 303
- diffusivity
 - magnetic, 242
- direct current, 9
- discontinuity
 - evolutionary, 239, 356
 - non-evolutionary, 239, 355
 - tangential, 355
- dispersion equation, 244, 277, 283
- displacement
 - antisymmetric, 348
 - magnetic footpoints, 297, 348
- dissipation
 - dynamic, 37, 45, 160
 - Joule, 37
 - magnetic helicity, 304
- dissipative wave, 246
- double layer, 340
- Dreicer field, 45
- drift
 - electric, 9, 14, 215
 - gradient, 14
- Dungey, 21
- dynamic chaos, 219
- dynamic dissipation, 34, 45, 160
- dynamo
 - photospheric, 329
 - solar, 302
 - turbulent, 300
- Earth
 - plasma sheet, 301
- electric circuit, 340
- electric conductivity
 - isotropic, 270
- electric drift, 9, 14
- electric field, 19
 - Dreicer, 194

- generation, 8, 54
- electric runaway, 45
- electron resonance, 291
- energy conservation law, 290
- energy surface, 222
- entropy wave, 245
- equation
 - continuity, 31
 - diffusion, 356
 - dispersion, 244, 277
 - Fokker-Planck, 311
 - freezing-in, 31
 - Grad-Shafranov, 345
 - kinetic, 288
 - linear oscillator, 19
 - motion, 16
 - oscillator, 216
 - Vlasov, 288
 - wave, 28
- equations
 - ideal MHD
 - linearized, 27
 - magnetic field line, 351
- equipartition, 300
- evolutionarity
 - conditions, 240
 - criterion, 260
 - current layer, 240, 265
 - fast shock wave, 240
 - slow shock wave, 240
- Fermi acceleration, 172, 307
- filament
 - channel, 326
 - dextral, 327, 343
 - formation, 320
 - sinistral, 327, 343
- fireball, 209
- flare
 - avalanche model, 297
 - chromospheric, 3
 - electron-dominated, 311
 - eruptive, 361, 362
 - giant, 208
 - homologous, 74
 - in astrophysical plasma, 1
 - solar, 1, 5, 21, 46, 54, 147, 201, 211, 217, 305, 307, 311, 361
 - spaghetti model, 297
 - standard model, 82, 117, 166
 - stellar, 1
 - topological trigger, 224
 - turbulent cascade, 298, 307
 - white, 322
- flow
 - shear, 50
- fluid particle, 31
- flux cancellation, 305, 320, 326
- Fokker-Planck equation, 311
- force
 - Coriolis, 305
 - magnetic, 19
- force-free field
 - helicity, 298
 - linear, 299, 305, 354
 - non-linear, 305
- fractionation
 - elements, 328
 - FIP effect, 328, 332
- free magnetic energy, 13, 340
- freezing-in equation, 31
- frequency
 - neutral-ion collisions, 325
- galaxy
 - spiral, 1
- geomagnetic tail, 8, 225, 227, 291, 293
- geospace, 4
- giant flare, 208
- Giovanelli, 21
- gradient drift, 14
- group velocity, 245

- Hall current, 337
- Hamiltonian
 - transformed, 221
 - usual, 220
- heating
 - coronal, 297
- helicity
 - global, 317
- helioseismology, 303
- Hinotori, 159

- ideal MHD, 27
- initial conditions, 24
- instability
 - fire-hose, 308
 - structural, 64, 239
 - tearing, 9, 64, 269
 - thermal, 64
- interaction
 - magnetic fluxes, 5
 - wave-particle, 45, 140, 160, 214
- interface dynamo, 304
- invariant
 - adiabatic, 172
 - motion, 220
- inverse cascade, 302
- involution, 221
- ion resonance, 292

- Joule heating, 325, 356

- kinematic problems, 302
- kinetic energy, 290
- Kolmogorov turbulence, 302

- Lagrangian coordinates, 31
- Landau resonance, 291
- Larmor radius, 9, 16, 219, 289
- law
 - Ohm's, 281
- layer
 - boundary, 345
 - double, 340
- Lundquist number, 135

- magnetar, 1, 236
- magnetic collapse, 44
- magnetic diffusivity, 242, 273, 356
- magnetic dynamo, 300
- magnetic field
 - bald patch, 354
 - completely open, 344
 - cumulative effect, 29
 - force free, 298, 344
 - galactic, 1
 - linkage, 298, 347
 - longitudinal, 19, 136, 212, 220, 353
 - poloidal, 303, 347
 - potential *or* current free, 7, 344
 - separator, 137
 - strong, 299
 - toroidal, 303, 351
 - transversal, 19, 46, 136, 212, 220, 271
 - weak, 300
 - zeroth point *or* line, 5, 21, 24, 237, 271, 345
 - peculiar, 24, 237
- magnetic field line
 - equations, 351
 - separator, 3, 341, 347
 - separatrix, 7, 271, 345, 347
- magnetic flux, 347
 - emerging, 6
- magnetic flux conservation, 350
- magnetic flux tube
 - closely packed, 297
 - specific volume, 350
- magnetic force, 19
- magnetic helicity, 58, 305, 327
 - change, 302
 - conservation, 299
 - dissipation, 304

- global, 298, 317
- magnetic mirror, 172
- magnetic obstacle, 169
- magnetic reconnection, 3, 8, 21, 200, 269, 297
 - collisionless, 139
 - of electric currents, 341
 - Petschek's regime, 238, 266
- magnetic Reynolds number, 302
- magnetic storm, 1
- magnetic stresses, 304
- magnetoacoustic wave
 - fast, 246
 - slow, 245
- magnetosphere
 - Earth, 1, 171, 201
- magnetospheric substorm, 1, 291, 293
- magnetospheric tail, 136
- mean field, 300
- MHD turbulence, 299
- minimum current corona, 64, 74, 345
- momentum
 - generalized, 220
 - longitudinal, 172
- motion
 - shear, 346
- nanoflare, 313
- near space, 3
- neutron star, 1, 236
- Ohm's law
 - generalized, 325
 - in MHD, 281
- particle
 - fluid, 31
- peculiar zeroth point, 24, 237
- phase space, 222
- phase trajectory, 222
- pinch effect, 331
- pitch-angle, 172
- plasma
 - collisionless, 37
 - super-hot, 158
 - weakly-ionized, 319, 328
- plasma motion
 - continuous, 24
- plasma sheet, 301
- plasma turbulence
 - marginal regime, 145
 - saturated regime, 145
- Poisson brackets, 221
- potential
 - magnetic field, 7
 - vector, 8, 23
- Poynting vector, 316
- prominence, 319
 - filament, 320
 - quiescent, 325
- pulsar
 - magnetosphere, 203
 - millisecond, 208
- quasar, 1
- radiative losses, 325
- reconnecting current layer, 9, 320
- reconnection
 - collisionless, 8, 37, 46, 168
 - fast, 266
 - in vacuum, 8
 - linear, 30, 320, 323
 - magnetic, 3, 8, 21, 200
 - two-level, 315
 - weakly-ionized plasma, 314, 319, 328
- resonance
 - Landau, 291
- reverse current, 9, 34, 241
- RHESSI, 2, 97, 162, 362
- runaway
 - electric, 38, 45, 66
- self-inductance, 63

- self-organization, 299
- self-similar solution, 38
- separator, 52, 142
- separatrix, 7, 52, 345
- shear, 50, 107, 305, 346, 355
- shear relaxation, 109, 121
- shock wave
 - oblique
 - fast, 171
- sigmoid structure, 362
- SMM, 159
- SOHO, 2, 62, 67, 74, 78, 126, 170, 313, 332
- solar activity, 302
- solar atmosphere, 5
- solar corona, 8, 311, 328
- solar cycle, 303
- solar wind, 3, 201, 300, 328
- Solar-B, 362
- space
 - near, 3
 - phase, 222
 - pseudo-phase, 224
- space weather, 3, 201
- specific magnetic volume, 350
- splitting
 - current layer, 238
- star
 - cataclysmic variable, 208
 - magnetar, 208
 - neutron, 1, 202, 207, 208
 - Sun, 1
 - supernova, 1
 - T Tauri, 208
- stochastic acceleration, 307
- stress heating, 316
- structural instability, 239
- Sun
 - active region, 2, 6, 243, 297
 - atmosphere, 2
 - chromosphere, 3, 6, 320
 - corona, 243
 - photosphere, 2, 6, 320, 339
 - surface wave, 248
 - Syrovatskii, 22, 131, 134
- tachocline, 303
- tangential discontinuity, 242, 355
- Taylor hypothesis, 299
- tearing instability, 9, 64, 269
 - electron, 291
 - ion, 292
 - nonlinear, 294
- theorem
 - virial, 344
 - Woltjer, 298
- thick target, 311
- thin target, 311
- topological interruption, 339, 346, 357
- topological trigger, 107
- TRACE, 2, 67, 68, 75, 78, 103, 126, 362
- trigger
 - tearing instability, 269
 - thermal, 134
 - topological, 107, 224
- turbulence
 - current-driven, 193
 - fluid, 299
 - helical, 303
 - ion-acoustic, 145, 211, 214
 - ion-cyclotron, 145
 - Langmuir, 235
 - MHD, 299
 - plasma, 213
 - reconnection-driven, 307
 - strong, 300
- twist, 305, 334, 345
- vector potential, 8, 11, 23
- velocity
 - group, 245
- virial theorem, 344

- viscosity
 - ion, 160
- Vlasov equation, 288
- wave
 - dissipative, 246
 - entropy, 245
 - magnetoacoustic
 - fast, 246
 - slow, 245
 - surface, 248
 - wistler, 313
- wave heating, 316
- white flare
 - type II, 322
- Woltjer theorem, 298
- X-ray emission
 - hard, 69
- X-type zeroth point, 7, 21, 53, 137,
142, 240, 271, 345
- Yohkoh, 2, 62, 68, 69, 74, 77, 126,
158, 168, 199, 315, 362

Color Plates

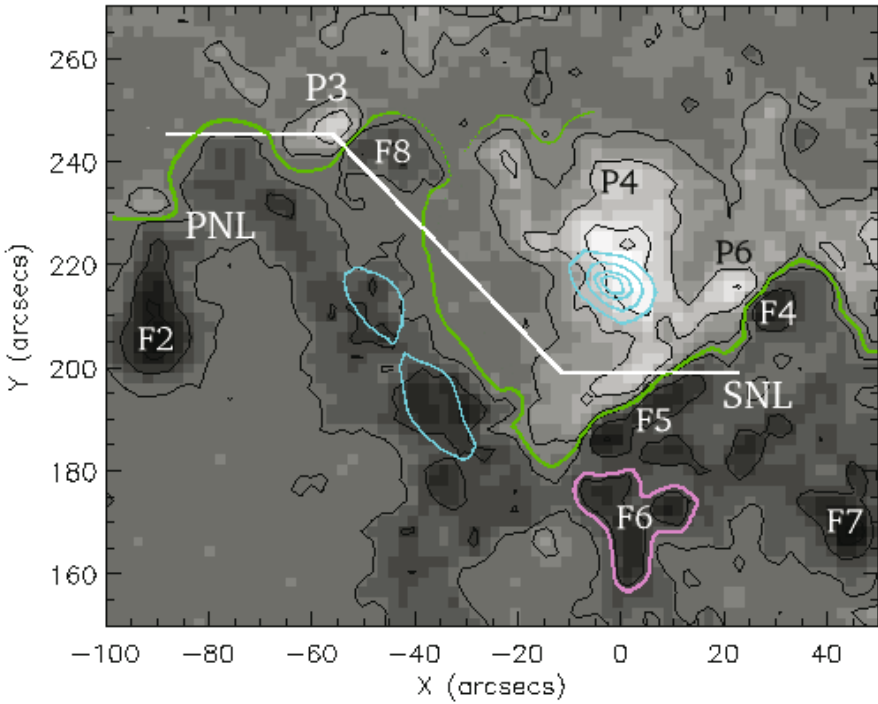


Fig. 4.2. The HXR source contours (blue curves) at the HXR maximum of the Bastille day flare overlaid on the MDI magnetogram. The green curve PNL represents the photospheric neutral line. SNL is the simplified neutral line.

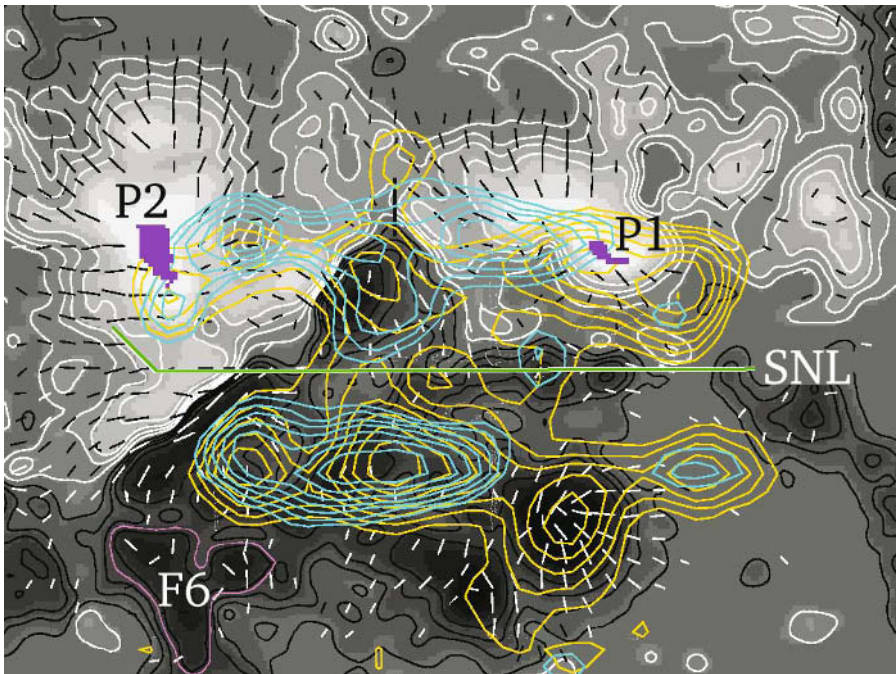


Fig. 4.3. The HXR source positions in the beginning of the first HXR spike S1 (yellow contours) and near its end (blue contours).

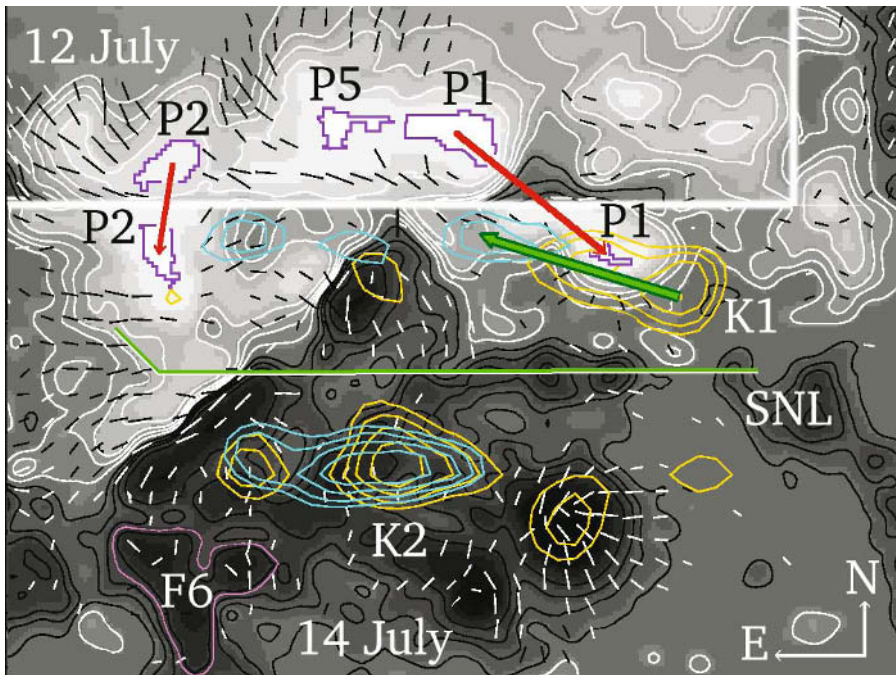


Fig. 4.4. The position and motion of the strongest HXR sources K1 and K2 relative to the SMFT magnetogram on 14 July.

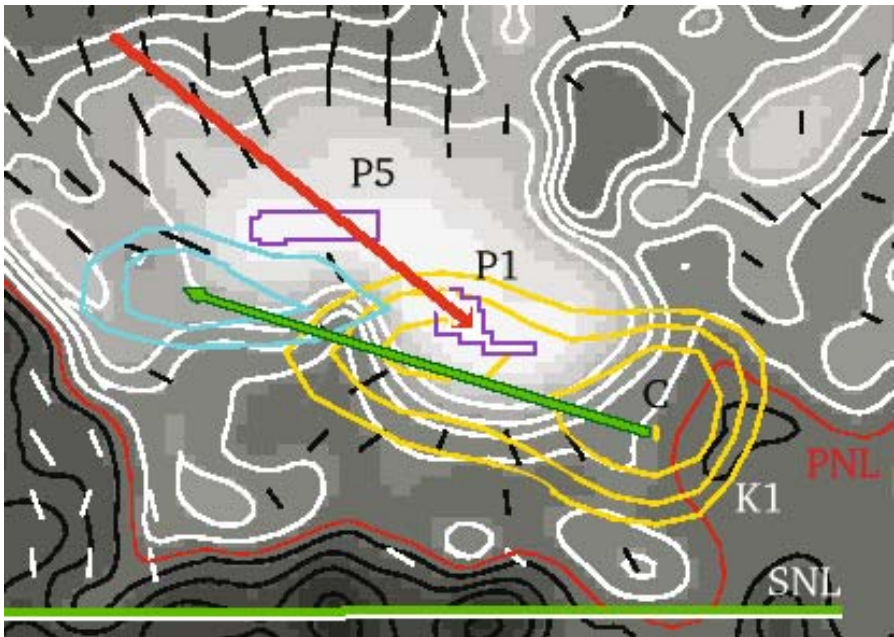


Fig. 4.5. H-band images of the brightest kernel K1 in the rise and decay of the first HXR spike S1 overlaid on the SMFT magnetogram on July 14.