NOTE ON THE RINGS OF SATURN

(Letter to the Editor)

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The spokes in the middle ring of Saturn photographed by the recent Voyager spacecraft are enigmatic. Because the linear dimensions of the spoke are large compared with the root of their cross-sectional area, self gravitational efforts are negligible. The gravitational effect of other satellites is likewise small. In the absence of non-gravitational fields the material should therefore move, to a high degree of approximation, in circular orbits according to Kepler's third law

$$\tau = \frac{2\pi r^{3/2}}{GM}, \tag{1}$$

where τ is the period of the orbit, r the orbital radius of the particle, G the universal constant of gravitation and M the mass of Saturn. The angular rotation rate ω is thus

$$\omega = GMr^{-3/2}. \tag{2}$$

The spokes extend over an appreciable fraction of the radial distance and any gravitational effect other than that caused by the planet would cause only small deviations from the prediction of Equation (2). The Voyager observations show that the spokes have lifetimes of several hours. Since it is known that the particles are of various sizes it seems quite unlikely that any electromagnetic field could evacuate and replenish material over such great distances in such a short time.

In view of this apparent dilemma I wish to suggest that the spokes do not represent changes in real density of the rings but changes in albedo (brightness). A change in albedo could easily be caused simply by a change in orientation of some appreciable fraction of the particles. One possible cause for such a change would be a corresponding change in the local electromagnetic field. (Clustering and dispersal of small particles – possibly electrostatically induced – might present an alternative which could change the albedo). The idea presented here requires no large scale mass motion other than that predicted by (2). Indeed it is possible that the spoke velocities and particle velocities of rotation could differ. The particles of the rings could thus move through the spokes at a velocity given by Equation (2) and not correlated with the spoke rotational velocity. The orientation of the particle and thus its contribution to the albedo would however, depend on whether or not at any instant it lay within a spoke.

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