



Editorial

Where Is the Physics Frontier?

The historian Frederick Jackson Turner famously argued that the Western frontier defined the early American state and that the ideals and necessities of frontier life were therefore etched into the American psyche. Physics provides ample evidence that Turner's Frontier Thesis can be a useful way to think about American science. The frontier holds unimagined phenomena that can lead to new insights, and so it enchants American physicists in much the same way it enchanted the American writers Owen Wister and Willa Cather, whose novels propagated a romantic vision of pioneer life. Basic researchers view the frontier as a kind of Great Attractor—it is the place to head for; any other district is *déclassé*.

Yet, like the Western frontier, the physics frontier is shifting and precarious. An area may promise new and revolutionary physics—the puzzle of self-energy in the 1930s and 1940s, say—but then turn out to be explicable in relatively conventional terms. Or an area viewed as thoroughly explored and having few new insights to deliver—thermodynamics in the 1890s—may turn out to harbor truly revolutionary physics: the quantum. Given the abundance of such examples, historians might easily dismiss physicists' frontier talk as fickle and lacking perspective. But whether or not a field is perceived as lying on frontier matters, for it affects the type and quality of the resources devoted to it, and thus its research.

Gary J. Weisel's analysis of the plasma physics community in this issue illustrates just how complex and unstable the idea of the scientific frontier can be. Weisel notes "the judgment by the general physics community that plasma physics was nowhere near the frontier of research." Plasma physics, indeed, seemed to have all the hallmarks of a field far from the frontier. It elaborated on classical theory during the heyday of quantum mechanics. It flirted with industrial and military relevance at a time when distance from technical applications was a mark of purity. It reveled in complexity even though physicists widely regarded the simplicity sought by particle theory to be the cutting edge. The consequent judgment of plasma physics as unfashionable was "both a determinant and a consequence of its patron relationships," Weisel argues.

Despite these contemporary judgments, plasma physics turned out to have hidden significance for several important areas of science and technology. Its relevance to fusion made it essential to the theoretical study of stars. It proved essential for the aerospace research that pushed humankind into the "final frontier"—outer space. Late in the twentieth century, some physicists began

questioning whether the “complexity frontier” of the sort found in plasma physics might offer vistas just as stunning and fields just as fertile as the high energy frontier. Weisel’s article shows that, however powerful its appeal, the characterization of a field as a frontier is a dubious guide to future returns from basic research. His article forces readers to wonder what, in the end, designating a “frontier” really accomplishes in science. When does it reflect an informed professional judgment about the site of the next big discoveries? When is it part of a public relations strategy, something to tell legislators and funders so they do not allocate money to someone else, or to tell journalists in order that they might write stories about you?

Historians must balance their critical assessments of frontier talk with a sensitivity to the institutional purposes it serves. A highly vaunted frontier area may well be replete with new discoveries, but it can just as readily wind up a barren ghost town. Such a designation can also function rhetorically to shore up valuable resources for what in retrospect appears to be incremental progress through well-mapped territory. Historians must also be on the lookout for areas regarded as passé that later turn out to indicate important new directions—and attempt to explain how this happened. It is difficult for participants caught up in the frenzy of research to do this. Even apart from issues of funding, physicists are not immune from being caught up in passing fashions in their field. Historical perspective gives insight into these social movements, insight especially important when physics as a discipline concerns itself primarily with achieving its scientific objectives, rather than with the growth and dynamics of the ideals, institutions, and community priorities that guide that journey.

Weisel focuses on the institutional evolution of plasma physics, how its financial and personnel resources were directed to different topics within it, and his approach highlights where the analogy between geographical frontiers and conceptual frontiers breaks down. The West as idealized in American cultural mythology can make us forget that frontiers are wild places. The American frontier was difficult to access, composed of hardscrabble landscapes that entailed life red in tooth and claw. These hardships were only worthwhile because opening the frontier promised to make the natural resources it held available. We can see similar dynamics at play when taking a historical perspective on physical frontiers. But whereas pioneers traveled west to seek out the resources available there, physicists characterize areas as frontiers not because they are certain that they contain resources, but because they hope to have resources directed there. In twentieth-century American physics, frontier talk represented a dependence on, rather than independence from, a centralized source of support. Historians of physics must keep this difference in mind.

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