P-208-A

"Incommensurable" Paradigms in the Debate on Nonthermal Effects of Electromagnetic Fields

Carolyn R. Miller,* North Carolina State University NC STATE UNIVERSITY

Bioelectromagnetics Society, 25th Annual Meeting, Wailea, Hawaii, June 2003

ABSTRACT/INTRODUCTION

The debate over nonthermal effects of nonionizing radiation that has developed over the past 50 years presents a case example of Thomas Kuhn's notion of incommensurable paradigms. Kuhn used the notion of incommensurability to characterize the differences between successive "paradigms" or explanatory frameworks in the history of science. In addition to his overarching metaphor of political "revolution," he invokes the models of gestalt psychology, religious conversion, and linguistic translation in an effort to describe the irreconcilability of scientific worldviews that develop in the course of scientific change over time. EMF research illustrates Kuhn's claim that anomalous results that cannot be accommodated by an existing explanatory framework lead to debate and contention.

However, the EMF case complicates Kuhn's picture because it concerns not only change over time but also the problems of interdisciplinary inquiry. Differences in worldview in the EMF case derive not only from the differential acceptance of a newly proposed explanatory framework within a single scientific community but also from different long-standing and deeply engrained commitments and styles of thinking in separate disciplines.

This study characterizes these differences by examining the argumentative strategies used in the debate. First, the intellectual commitments and styles of the major disciplines contributing to the debate, the biological sciences (both experimental and epidemiological) and the physical sciences (including engineering), are contrasted through an analysis of the preferred argumentative appeals used to explain novel results. Second, the socio-political dynamics of the debate are examined by viewing it as an asymmetric contest between defenders of an orthodoxy and heretical challengers.

Ultimately, this analysis suggests that incommensurability is not a particularly productive way to characterize differences between disciplinary commitments. As a mathematical concept, incommensurability emphasizes the logical relationships among concepts. It is more productive, and more explanatory, to understand disciplinary debate as the result of both intellectual and socio-political dynamics. The intellectual dynamic plays out as a tension between novelty and tradition, and the socio-political dynamic plays out as a tension between heresy and orthodoxy.

> *"The normal-scientific tradition that emerges from a scientific revolution is … often incommensurable with that which has gone before ."*
>
> Kuhn, p. 103

SAMPLE DATA SOURCES

American Physical Society. Statement on Power Line Fields and Public Health. 1995 1995. website. American Physical Society. Available: http://www.aps.org/statements/95.2.html. 5 May 2002.

Bioelectromagnetics Society Presidents. BEMS Presidents' Letter to the Congress. 1996 1996. website. Biolectromagnetics Society. Available: http://www.bioelectromagnetics.org/newsletter/news131.html#BM2. 5 May 2002.

Committee on Interagency Radiation Research and Policy Coordination. Health Effects of Low-Frequency Electric and Magnetic Fields. Washington, DC: Oak Ridge Associated Universities, 1992.

National Institute of Environmental Health Sciences. Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields: National Institutes of Health, 1999.

U.S. National Research Council, Committee on the Possible Effects of Electromagnetic Fields on Biologic Systems. Possible Health Effects of Exposure to Residential Electric and Magnetic Fields. Washington, DC: National Academy Press, 1997.

* * *

Adair, R. K. "Constraints on Biological Effects of Weak Extremely-Low- Frequency Electromagnetic-Fields." Physical Review A 43.2 (1991): 1039-48.

Adair, R. K. "EMF Research." Science 258 (1992): 1868-69.

Adey, W. R. "Biological Effects of Electromagnetic Fields." Journal of Cellular Biochemistry 51.4 (1993): 410-16.

Bennett, William Ralph, Jr. Health and Low-Frequency Electromagnetic Fields. New Haven, CT: Yale University Press, 1994.

Jackson, J. D. "Are the Stray 60-Hz Electromagnetic Fields Associated with the Distribution and Use of Electric Power a Significant Cause of Cancer?" Proceedings of the National Academy of Sciences of the United States of America 89 (1992): 3508–10.

Park, Robert L. "Power Line Paranoia." New York Times 13 November 1996: A 23.

Savitz, David A. "Commentary on Health Effects of Low-Frequency Electric and Magnetic Fields." Environmental Science and Technology 27.1 (1993): 52–54.

Tenforde, Thomas S. "Lowdown on Low Magnetic Fields." Rev. of *Health and Low-Frequency Electromagnetic Fields* by William R. Bennett. IEEE Spectrum 32.10 (1995): 10, 12.

Wertheimer, Nancy, and Ed Leeper. "EMFs and Cancer Rates (letter)." Microwave News 12.4 (1992): 14.

* * *

Plus news coverage in Microwave News, New York Times, and Science, as well as letters and commentary in these and other sources.

> *"The proponents of competing paradigms practice their trades in different worlds."*
>
> Kuhn, p. 150

ANALYSIS 1: INTELLECTUAL DYNAMICS NOVELTY OR ANOMALY?

PHYSICAL SCIENCES

Characteristic arguments: agreement, cause, impossibility, appearance vs. reality, *a fortiori*, and implicit reductionism. Implications: rational ontology, deductive epistemology, axiomatic world from which phenomena deduced; anomaly dismissed as inconsistent and impossible.

Examples Cause-->impossibility (a fortiori)-->reality

Agreement (lack of), cause
"Epidemiologic findings of an association between electric and magnetic fields and childhood leukemia or adult cancers are inconsistent and inconclusive. No plausible biological mechanism is presented that would explain causality." (CIRRPC Report 1992)

A fortiori, impossibility
"The electric and magnetic fields … from external ELF-EMF sources are … generally much weaker than intrinsic fields created by the normal, natural thermal movement of ions within the body." (CIRRPC 1992)

Impossibility
"Biological mechanisms … cannot violate the fundamental laws of physics." (Bennett 1994)

Appearance vs reality
"Experimental errors have been accepted as real effects." (Adair 1992)

BIOLOGICAL SCIENCES

Characteristic arguments: past fact, complexity, and possibility with some attention to agreement and credibility. Implications: phenomenological ontology, inductive epistemology; empirical world in which appearance is meaningful and anomaly requires novel explanation.

EXAMPLES

Agreement, past fact
"Epidemiologic evidence linking power lines near residences and elevated magnetic fields to childhood cancer continues to accrue; … there have been numerous laboratory studies indicative of influences on circadian rhythms…" (Savitz 1993)

Future fact (possibility)
"As evidence has mounted confirming occurrence of bioeffects of EM fields … there is a mainstream of theoretical and experimental studies seeking the first transductive steps." (Adey 1993)

Complexity
"Electric and magnetic fields, unlike many other environmental agents, are not characterized by a single quantity but involve many different factors." (BEMS Presidents 1996)

PRELIMINARY CONCLUSION 1

These contrasting patterns of argument illustrate how two scientific traditions struggle with anomalous findings. They suggest that intellectual differences may not be due to mutual incomprehension so much as to differing argumentative preferences. The "different worlds" Kuhn described are in an important way rhetorical worlds.

ANALYSIS 2: SOCIO-POLITICAL DYNAMICS HERESY AND ORTHODOXY

Kuhn emphasizes the necessity of the "paradigm" to normal science. As a "strong network of commitments — conceptual, theoretical, instrumental, and methodological" the paradigm defines the science, requires the allegiance of its practitioners, and accounts for the "relative unanimity of their professional judgments." The power of the paradigm in science is such that it functions as an orthodoxy.

When challenged, an orthodoxy protects itself and its authority; a number of defensive strategies have been identified (Lessl 1988; Sullivan 2000):

Forum control—controlling internal communication through peer review, membership on committees, etc.

Strategies of argument—public ***correction***, ***ridicule***, ***questioning*** competence and ***motives***

Boundary work—driving out the heresy and/or the heretic, ***scapegoating***, ***closure***

In the EMF debate, many of these defensive strategies are used, and some are used by both sides, because part of the disagreement is over who controls the orthodoxy. However, physical scientists make the stronger claim to ownership of the orthodoxy and thus to the authority it entails, and they engage in more defensive moves. Their claim is based at least in part on the longer history and higher status of physical science (for example, no Presidential Science Advisor has been a biological scientist).

EXAMPLES

Forum control
Disagreements about membership of review panel for 1991 EPA draft report (*Science* 1991), about NCRP committees for RF/MW standards and for revising 1986 report on RF exposure (*Microwave News* 1995).

Correction
Physicist: EPA's "findings of a 'positive association' between EMFs and childhood cancer are 'quite incorrect'" (Bromley in *Microwave News* 1991).

Biologist: The CIRRPC report claims that "electric or magnetic fields could not adversely affect health because the rise in electric power use over time has not produced epidemics of cancer, birth defects, or miscarriage. In fact, the two observations are true but unrelated." (Savitz 1993)

Ridicule
Physicist: "If fields of two milligauss really are a serious threat … then commuters on East coast electric trains—where the fields at power line frequencies can be hundreds of times larger—ought to be dying like flies." (Bennett 1994)

Biologist:" Accepting the article by [Bennett] as guidance on the question of health effects of [EMFs] seems to me analogous to accepting the advice of the village blacksmith on how to fix your Swiss watch." (quoted in *Microwave News* 1995)

Questioning motives
By physicist: "The self-interest that leads to scientists grossly exaggerating the linkage between their researches and health effects is also enormous." (Adair 1992)

Boundary work
By physicist: "My role as science advisor to the president is to be sure that statements that come out of this administration are based on sound science." (Bromley in *Microwave News* 1991)

Scapegoating
The Liburdy affair, physicist: "Liburdy's deception was probably typical for the field." (Park in *New York Times* 1999)

Closure or openness?
Physicist: "Scientifically, it's essentially over now. I hope this puts the whole issue to rest." (Park quoted in *New York Times* 1996)

Biologists: "A great deal is yet to be discovered about the interaction of EMFs with biological systems." (BEMS Board of Directors 1996)

PRELIMINARY CONCLUSION 2

The social dynamics of the debate play out not only within the scientific community but also in the public forum. When heresy cannot be controlled from within, and when different disciplines struggle over the ownership of orthodoxy, the debate spills over into to a larger community. The EMF debate plays out in public also because there are multiple interests, including public interests, involved.

Arguments about closure and openness are efforts to determine the future of the community. What is at stake is control of the orthodoxy, and of the community—where are the boundaries? who are the authorities? what is the research agenda?

> *"The transfer of allegiance from paradigm to paradigm is a conversion experience that cannot be forced. Lifelong resistance, particularly from those whose productive careers have committed them to an older tradition … , is not a violation of scientific standards but an index to the nature of scientific research itself."*
>
> Kuhn, p. 151

DISCUSSION AND CONCLUSIONS

The EMF debate illustrates well the features of scientific debate that led Kuhn to postulate incommensurability; it also illustrates many features that suggest the inadequacy of Kuhn's metaphor.

Kuhn used the notion of incommensurability to describe the "mutual incomprehension" between adherents of different paradigms of scientific thought. Drawn from mathematics, this metaphor implies that the conflicting ideas themselves cause of the incomprehension because no single logic can accommodate both. And because the ideas are incommensurable, argument is fruitless and proof impossible. Although Kuhn recognized paradigm debates as matters of persuasion, not logic, he failed to pursue the explanatory potential of theories of argumentation and persuasion. Such theories cannot determine who is right or how to ensure victory, but they can provide some insight into why arguments seem unproductive and opponents seem stubborn or obtuse.

Anomaly can be welcomed as productive scientific novelty that contributes to the growth of scientific knowledge, or it can be rejected as scientific heresy that must be corrected or expunged. What Kuhn called "incommensurability" can be understood alternatively and more productively as the result of these rhetorical dynamics, which involve a complex combination of both intellectual commitments and socio-political relations.

> *"In science, … novelty emerges only with difficulty, manifested by resistance, against a background provided by expectation."*
>
> Kuhn, p. 64

SELECTED ADDITIONAL SOURCES

Gieryn, Thomas F. "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists." American Sociological Review 48 (1983): 781–95.

Fahnestock, Jeanne. "Arguing in Different Forums: The Bering Crossover Controversy." Science, Technology, and Human Values 14.1 (1989): 26–42.

King, Andrew. "The Rhetoric of Power Maintenance: Elites at the Precipice." Quarterly Journal of Speech 62 (1976): 127–34.

Kuhn, Thomas S. The Structure of Scientific Revolutions. 1962. 2nd ed. Chicago: University of Chicago Press, 1970.

Lessl, Thomas M. "Heresy, Orthodoxy, and the Politics of Science." Quarterly Journal of Speech 74.1 (1988): 18–34.

Mercer, David. "Scientific Method Discourses in the Construction of 'EMF Science': Interests, Resources and Rhetoric in Submissions to a Public Inquiry." Social Studies of Science 32.2 (2002): 205–34.

Sullivan, Dale. "Keeping the Rhetoric Orthodox: Forum Control in Science." Technical Communication Quarterly 9.2 (2000): 125–46.