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Kirchhoff's Law and Magnetic Resonance Imaging: Do Arbitrary Cavities Always Contain Black Radiation? PIERRE-MARIE ROBITAILLE, The Ohio State University — When Max Planck attempted to derive Kirchhoff's Law, he placed the energy in the radiation field, leaving none in the walls of the cavity. Theoretically, blackbody radiation became independent of the nature of the enclosure. Others incorrectly argued that any cavity devoid of black radiation would constitute a violation of the Second Law of Thermodynamics. This logical misstep occurred when no energy was allowed to reside in the walls. However, both NMR and MRI depend on spin-lattice relaxation and the inherent presence of energy within the structural lattice. It takes little insight to recognize that if Kirchhoff's Law was correct, then NMR would not exist, as the spins would be stripped of relaxation mechanisms which depend on energy in the lattice. In reality, real materials can restrict lattice energy which, as a result of structural constraints and conduction bands, can remain forever unavailable to thermal emission. It was therefore improper to assume that all of the energy can be localized in the radiation field. Furthermore, microwave cavities are known to support standing waves, not black radiation. This is potentially true of any material with elevated reflectivity, an aspect central to MRI, as this reality ensures that spins can be both excited and detected with cavities. It remains a fact that blackbodies are made of specialized strongly absorbing materials and that arbitrary cavities do not contain black radiation. Kirchhoff's Law remains without theoretical or experimental confirmation and is directly refuted by the very existence of clinical MRI.

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