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Eddington's Mass-Luminosity Relationship: A Violation of the Laws of Thermodynamics STEPHEN J. CROTHERS, None, PIERRE-MARIE ROBITAILLE, Ohio State University — In 1924, A.S. Eddington accounted for the mass-luminosity relationship of main sequence by advancing an expression for luminosity, L, based on gaseous stars in hydrostatic equilibrium. His relation $L=4\pi cGM(1-\beta)/k_o$ (where c is the speed of light in vacuum, G is the universal constant of gravitation, M is the mass, β is a constant pure number relating gas pressure (P_G) to total pressure ($P_G = \beta P$), and k_o is the stellar opacity) is not thermodynamically balanced. This is because luminosity is a homogeneous function of degree 2/3, while mass, M, is a homogeneous function of degree 1. By incorporating $L= \sigma AT^4$ (where σ is the Stefan-Boltzmann constant, A is the surface area ($4\pi R^2$, R is the radius), and T the temperature) one obtains: $L/A=cGM(1-\beta)/R^2k_o = \sigma T^4$. Here, L/A is intensive (L and A are each homogenous functions of degree 2/3); T (and also T^4) is always intensive, a homogeneous function of degree 0. But note that since M has degree 1, while R^2 has degree 2/3, the central term has degree 1/3, which is not intensive. Eddington has made temperature and L/A non-intensive and violated the laws of thermodynamics, as temperature must always be intensive. This analysis proves that gases cannot account for the mass-luminosity relation. Further, the stars must be made of condensed matter in order to produce their emission spectrum. Eddington's opacity arguments never had merit. Unlike what Eddington, Kirchhoff, and Planck believed, the creation of a thermal spectrum requires more than thermal equilibrium with an opaque enclosure. It requires a vibrational lattice.

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