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Thermodynamic modifications to spectral analysis and radiative transfer models of dust: Implications for asteroids, circumstellar dust, and gravitational collapse

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Radiative transfer of light under diffusive conditions is important to astronomy, engineering, and planetary interiors. Three different errors exist in models, arising from failure to incorporate thermodynamic constraints. 1) Emissions have been mistaken for emissivity in analyzing spectra because the effect of thermal gradients in partially transparent solids was ignored. Applying the correct form of Kirchhoff's law to surfaces of large asteroids indicates mineralogies commonly found in meteorites. 2) Refraction across interfaces has been modeled as conical emanations of a point source, but the 2^{nd} law of thermodynamics only permits heat to flow down the thermal gradient. We revise formula for the effective thermal conductivity and discuss heat flow in Earth's mantle and in dusty nebulae. 3) Because light speed is 5 orders of magnitude larger than speeds of most physical processes, quasi-radiative equilibrium is generally maintained. Specifically, dust clouds cannot heat up during gravitational contraction. We correct stability criteria. Formation of the solar system did not produce heat because the current rotational energy of the objects nearly equals their gravitational potential energy. For young dwarfs, the balance is exact. These examples indicate that substantial corrections are needed in radiative transfer models and data processing in astronomy and planetary science.