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Magnetic Accretion Funnels in Young Stellar Objects: Thermal Structure and Emission Signatures

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Abstract. A self-consistent procedure is outlined for determining the thermal structure of gas inflowing along magnetic field lines of a young stellar object. A young pre-main-sequence star (e.g., a classical T Tauri star) is assumed to possess a dipole magnetic field that disrupts a geometrically thin accretion disk and channels the incoming gas toward the stellar surface, leading to the formation of a pair of accretion funnels that terminate in shocks at high stellar latitudes. The heat equation is solved together with the rate equations for hydrogen, and the main physical processes that heat and cool the gas are identified. In particular, in the case of T Tauri stars, it is found that adiabatic compression is the principal heat source and that the Ca II and Mg II ions act as a powerful thermostat that regulates the gas temperature. The ionization state of the gas in the radiation field of the stellar photosphere and of the accretion shocks is found in this case to be controlled by Balmer continuum photons. The implications of these calculations to the observational signatures of accreting YSOs (e.g., their near-infrared hydrogen and CO overtone line emission) are discussed.

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