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Relaxing the assumption of subsonic flows in Enthalpy Based Thermal Evolution of Loops

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Field aligned 1-D simulations of coronal loops show that density, temperature, and pressure do not vary much across the coronal loop. Consequently, such quantities averaged over the coronal part of the loop, can be used to characterize the loop's coronal part and its thermodynamic evolution. This is referred to as 0-D description of coronal loops, which provides an efficient method for conducting an approximate but quick study of the thermodynamic evolution of coronal loops. EBTEL2 is a commonly used 0-D code, which models the mass and energy exchange between the corona and the transition region. It solves for density, temperature, and pressure, averaged over the coronal part, velocity at the coronal base, and instantaneous differential emission measure distribution in the transition region. EBTEL2 assumes that the flows are subsonic at all stages, hence, neglects the kinetic energy term. However, in some cases, simulations using EBTEL2, show supersonic flows during the impulsive phase, while 1-D simulations by HYDRAD show subsonic speeds. This is a potential limitation to EBTEL2's usage. Therefore, it becomes important to have the solutions of the full energy equation. Here, we upgrade EBTEL2 by adding kinetic energy (referred to as EBTEL3). We compare the new solutions with those obtained using EBTEL2 and 1-D hydrodynamic code HYDRAD. EBTEL3 guarantees subsonic flows in cases where HYDRAD shows subsonic flows. However, when HYDRAD produces supersonic flows, EBTEL3 produces unreliable Mach numbers, and velocities, despite other quantities being reliable. A simple criterion for predicting situations where this happens, is also discussed.

Primary authors: Mr RAJHANS, Abhishek (IUCAA, Pune, Maharashtra, India); Prof. TRIPATHI, Durgesh (IUCAA, Pune, Maharashtra, India); Prof. BRADSHAW, Stephen (Rice University, Houston, Texas, USA); Dr KASHYAP, Vinay (Center for Astrophysics | Harvard & Smithsonian, Cambridge, Massachusetts, USA); Dr KLIMCHUK, James (NASA, Goddard Space flight Center, Greenbelt, Maryland, USA)

Presenter: Mr RAJHANS, Abhishek (IUCAA, Pune, Maharashtra, India)

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