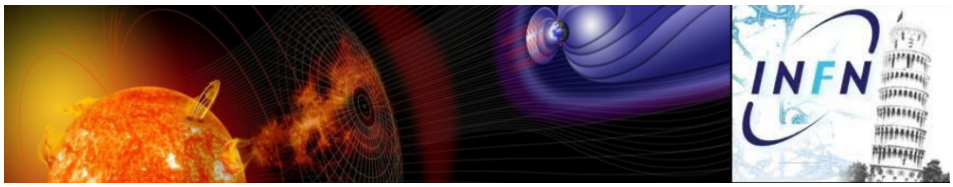

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He I 10830Å Dimming During Solar Flares: The Crucial Role of Non-Thermal Collisional Ionisations

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While solar flares are predominantly characterised by an intense broadband enhancement to the solar radiative output, certain spectral lines and continua will, in theory, exhibit flare-induced dimmings. Observations of ortho-helium spectral transitions (He I 10830Å and the He I D3 lines near 5876Å) have shown evidence of such dimming in some weak flares, usually followed by enhanced emission. It has been suggested that the presence of non-thermal collisional ionisation of helium by the electron beam, followed by recombinations to ortho-helium, is responsible for overpopulating the ortho-helium levels leading to stronger absorption. However it has not been possible observationally to preclude the possibility of overpopulating ortho-helium via enhanced photoionisation of He I by EUV irradiance from the flaring corona followed by recombinations. Here we present radiation hydrodynamics simulations of non-thermal electron beam-driven flares where (1) both non-thermal collisional ionisation of Helium and coronal irradiance are included, and (2) only coronal irradiance is included. A grid of simulations covering a range of total energies deposited by the electron beam, and a range of non-thermal electron beam low-energy cutoff values, were simulated. For each simulation the He I 10830Å line was forward modelled. In order to obtain flare-induced dimming of the He I 10830Å line it was necessary for non-thermal collisional ionisations to be present. Further, the effect was more prominent in flares with harder non-thermal electron spectrum (larger low-energy cutoff values) and longer lived in weaker flares and flares with a more gradual energy deposition timescale. These results demonstrate the usefulness of ortho-helium line emission as a diagnostic of flare energy transport.

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