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The variety of extreme blazars in the AstroSat view

In this contribution, we present a spectral study of extreme blazars (also eHBL) which are known to exhibit hard intrinsic X-ray/TeV spectra and extreme SED peak energies. We study four eHBLs 1ES 0120+340, RGB J0710+591, 1ES 1101-232, 1ES 1741+196 and one HBL 1ES 2322-409 using new X-ray data from AstroSat, together with quasi-simultaneous Fermi-LAT and other archival multi-frequency data. Three of the eHBLs are non-variable, as is typically attributed. On the contrary, RGB J0710+591 shows spectral softening in both X-ray and GeV bands indicating a significant change in the synchrotron cut-off. Typically, a standard one-zone synchrotron self-Compton (SSC) model reproduces well eHBL SEDs, but often requires a large value of the Doppler factor and minimum electron energy. We have thus conducted a detailed investigation of the broadband SEDs under both leptonic and (lepto-)hadronic scenarios. We employ 1) a steady-state one-zone synchrotron-self-Compton (SSC) code and 2) a one-zone hadro-leptonic (OneHaLe) code. The latter is solved for two cases of the high energy emission –a pure hadronic case (proton synchrotron) and a lepto-hadronic case (synchrotron emission of secondary electrons from pion decay and Bethe-Heitler pair production). By fixing the Doppler factor at δ=30, we find that all models can reproduce the SEDs of eHBLs. For the normal HBL, SSC and proton synchrotron models are superior to the lepto-hadronic model. As no model is superior explaining the eHBLs, we discuss in detail the pros and cons of each model.

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