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Asymmetric Backward Peaking Radiation Patterns from an Accelerated Relativistic Bremsstrahlung Particle In High Density Mediums

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Radiation patterns of combined parallel and perpendicular motions from the accelerated relativistic particle at low and high frequencies of the bremsstrahlung process with an external lightning electric field were explained. The primary outcome was that radiation patterns have four relative maxima with two forward peaking and two backward peaking lobes. The asymmetry of the radiation pattern, i.e., the different intensities of forwarding and backward peaking lobes, is caused by the Doppler effect. A novel outcome is that bremsstrahlung has an asymmetry of the four maxima around the velocity vector caused by the curvature of the particle's trajectory as it emits radiation (Yücemöz & Füllekrug, 2021). Further extended work reports another novel asymmetry in the overall radiation pattern from a single particle. Previously stated bremsstrahlung asymmetry, R was an asymmetry in the radiation lobe pairs about particle's velocity vector. Bremsstrahlung asymmetry used to occur at the same level (Same magnitude) in both forward radiation lobe pairs and backward radiation lobe pairs. However, in high-density mediums where the emitted wave can lag behind the speed of the particle, symmetry of the magnitude of bremsstrahlung asymmetry, R differs between forward peaking radiation lobe pairs relative to backward peaking radiation lobe pairs. This is another novel asymmetry and it causes bremsstrahlung asymmetry, R to be larger in the forward peaking compared to backward peaking radiation. Furthermore, bremsstrahlung asymmetry, R determines the magnitude of the Doppler effect in each radiation lobe which in turn enhances the increase in the difference in radiation length and increases the bremsstrahlung asymmetry further. A higher density medium causes backward peaking radiation length to decrease. Shrink in radiation length is higher in the backward direction as backward peaking lobes are always at a lower intensity and have low energies due to the Doppler effect. The effect of Doppler effect is larger on radiation lobes when the separation angle between two radiation lobes decreases. This is because decreasing the separation angle between two lobes brings two lobes closer into the line of direction of motion. Another conclusion is that forward and, backward peaking radiation patterns are not symmetrical around the particle's velocity vector in the case of bremsstrahlung asymmetry, R exists in straight-line trajectories. This extended mathematical modelling of the bremsstrahlung process into different high-density mediums helps to better understand the physical bremsstrahlung processes of a single particle's radiation pattern, which might assist the interpretation of observations with networks of radio receivers and arrays of γ-ray detectors.

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