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Proof-of-principle experiment of induced Compton scattering: a laser-plasma interaction around extreme astrophysical objects

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Pulsars and fast radio bursts are the astrophysical objects emitting coherent radiation, and their observed brightness temperature has exceeded 10^{35} Kelvin for some cases. The mechanism of the coherent radiation is a long-standing problem since the discovery of a radio pulsar in 1967. We do not even know the physical situation of the emission regions and "induced Compton scattering" is studied to constrain the environment of the emission region [1]. Induced Compton scattering is a nonlinear interaction of photons and electrons, and the consequence of induced Compton scattering is poorly understood. It is theoretically predicted that the spectra of the scattered light will be red-shifted and exhibit soliton-like features [2]. We have tried to demonstrate this extreme phenomenon in the universe using ultra intense lasers in laboratories [3]. In the presence of extremely high brightness temperature radiation such as pulsars and intense lasers, induced Compton scattering can be dominant in the interactions between light and rarefied plasma particles. We have performed the proof-of-principle experiment of the induced Compton scattering relevant to pulsars and fast radio bursts. The experimental observation is conducted in November 2022 with J-KAREN-P laser at National Institutes for Quantum and Radiological Science and Technology in Japan. Our results prove the existence of induced Compton scattering and will provide important information on the mechanism of pulsar emission and for other high-energy astrophysical phenomena.

References

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