

## Comparison of Two Theories for the Critical Laser Radius in Thermal Quantum Plasma

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**Abstract :** The critical beam radius is a significant factor that predicts the behavior of the laser beam in the plasma, so if the laser beam radius is adequately greater in comparison to it, the beam will experience stable focusing on the plasma; otherwise, the beam will diverge after entering into the plasma. In this work, considering the paraxial approximation and moment theories, the localization of a relativistic laser beam in thermal quantum plasma is investigated. Using the dielectric function obtained in the quantum hydrodynamic model, the mathematical equation for the laser beam width parameter is attained and solved numerically by the fourth-order Runge-Kutta method. The results demonstrate that the stouter focusing effect is occurred in the moment theory compared to the paraxial approximation. Besides, similar to the two theories, with increasing Fermi temperature, plasma density, and laser intensity, the oscillation rate of the beam width parameter grows and focusing length reduces which means improving the focusing effect. Furthermore, it is understood that behaviors of the critical laser radius are different in the two theories, in the paraxial approximation, the critical radius after a minimum value is enhanced with increasing laser intensity, but in the moment theory, with increasing laser intensity, the critical radius decreases until it becomes independent of the laser intensity.

**Keywords :** laser localization, quantum plasma, paraxial approximation, moment theory, quantum hydrodynamic model

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