

Gravitational Deflection of Light in Black-Hole Spacetimes: A Material Medium Perspective

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One of the most astonishing effects predicted by General Relativity (GR) is the deflection of light rays in a gravitational field. The curvature of spacetime induced by a massive body results in the curvature of the light rays' trajectories causing the effect of gravitational lensing. The effect of light deflection is a valuable tool for studying the gravitational properties of compact objects like Black holes (BHs). The most common tool for computing the light deflection is the null geodesic approach that has been widely used for modeling the gravitational lensing of compact bodies like BHs and neutron stars. Apart from the standard null geodesic approach, one may use the light deflection in a curved spacetime as an optical analog model. In such a scenario, the propagation of light waves is modeled as taking place within a medium whose refractive index depends on the gravitational field. The impact of the gravitational field on the path taken by the photon is thus regarded as arising due to the changes in the refractive index that lead to bending of light in a way similar to refraction in normal optical media. This optical model, popularly known as the Material Medium Approach, offers another simple way of studying gravitational lensing effects and has been successfully used in many BH spacetimes.