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Light Bending Under General Relativity: A study of pulsar blackhole binaries

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We present a fully general relativistic formalism to study propagation delays in the radio signals of pulsars in binary systems, arising from the gravitational bending of light. This bending delay is a significant contribution in neutron star–neutron star systems and becomes even more pronounced in neutron star–black hole binaries. Applying our framework to hypothetical neutron star–black hole systems, we find excellent agreement with previous approximate treatments near superior conjunction, while demonstrating that our method remains valid across all orbital configurations. Our formalism also reveals new features, including a characteristic discontinuity in the delay curve near conjunction. For the first time, we extend the calculation of bending delays to systems with rotating (Kerr) black hole companions. Finally, we show that light bending induces distortions in the apparent intensity distribution across the pulsar beam, leading to measurable pulse profile modifications and broadening.

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