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Geodesics near a curvature singularity of stationary and axially symmetric space-times

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In this work we study the local behavior of geodesics in the neighborhood of a curvature singularity contained in stationary and axially symmetric space-times. Apart from these properties, the metrics we shall focus on will also be required to admit a quadratic first integral for their geodesics. In particular, we search for the conditions on the geometry of the space-time for which null and time-like geodesics can reach the singularity. These conditions are determined by the equations of motion of a freely-falling particle. We also analyze the possible existence of geodesics that do not become incomplete when encountering the singularity in their path. The results are stated as criteria that depend on the inverse metric tensor along with conserved quantities such as energy and angular momentum. As an example, the derived criteria are applied to the Plebanski-Demianski class of space-times. Lastly, we propose a line element that describes a wormhole whose curvature singularities are, according to our results, inaccessible to causal geodesics.

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