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Abstract

Frequency Shift of Radio Signals in Curved Spacetimes

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This thesis considers the propagation of radio signals above the surface of the Earth. Suppose that a signal is emitted by a transmitter and follows two different trajectories towards a receiver. One of these trajectories is the direct trajectory between the emitter and the receiver and the other trajectory is reflected by geomagnetic field aligned irregularities, so called striations, in the ionosphere on the way between the emitter and the receiver. Experiments show that the signals arriving at the receiver differ in frequency. We begin by using the theory of General Relativity to show that in a stationary spacetime the frequency shift of a light or radio signal is only dependent on the endpoints of the trajectory traversed. This indicates that the frequency shifts observed in the experiments are only due to the reflection on the striations in the ionosphere. It has been suggested that the radio signal undergoes a frequency shift that is dependent on the whole trajectory, i.e., not only the endpoints. We examine the consequences of the existence of such a trajectory dependent frequency shift and compare the predictions with the results obtained from the experiments. The theoretical values obtained are of the order of magnitude of observed values. We also show that the presence of gravity does not change the predictions significantly. We conclude by proposing an experiment to prove or disprove the existence of the trajectory dependent frequency shift.

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