

Local Spacetime Dynamics, the Einstein-Straus Vacuole and the PIONEER Anomaly: A New Access to these Problems

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The question concerning the extent of the local spacetime has often been raised. At what circum-solar distance the well known Robertson-Walker spacetime of our expanding universe may become a valid approximation? Inside of that distance a local Schwarzschild metric, which permits to explain the Keplerian motions of planets within the frame of general relativity, must be applicable. We briefly analyze the historical answer to that question given by Einstein, Straus and their followers and show that till now this answer is unsatisfactory in many respects.

We revisit the problem of local spacetime geometries in the light of their effects on local photon propagation in view of the radiopropagation phenomena detected with the NASA spaceprobes PIONEER-10/11, waiting for a satisfying answer for several decades now. Comparing radiosignals outgoing from the earth to the probe and ingoing again from the probe to the receiver on earth do show anomalous frequency shifts which presently find no explanation by anomalous non-Newtonian decelerations of these probes. Therefore we study cosmological conditions for the transfer of radiosignals between the earth and these distant probes based on time dependent local spacetime geometries. First we study the cosmological redshift of radiophotons during their propagation to the spaceprobe and show that this shift in fact explains the registered PIONEER phenomenon under the assumption that the full cosmological expansion of the universe also takes place locally. Though yielding the right magnitude, one finds that this assumption leads to a redshift instead of the observed blueshift. We then, however, show that theoretically motivated forms of time dependent local spacetime metrics in fact lead to a blueshift of the needed magnitude. The appropriate local space vacuole is characterized by a Schwarzschild metric of a central mass increasing with cosmic time. Though it is clear that further studies of this effect have to be carried out to give more credit and verification to this hypothetical result, nevertheless more careful hightech radiotracking of freely flying spaceprobes may do a useful job in confirming a completely unexpected, but cosmologically highly relevant phenomenon.

Key words: Cosmology; General Relativity; Local Systems.