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Homogeneity of the universe emerging from the Equivalence Principle and Poisson equation: A comparison between Newtonian and MONDian cosmology

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A correspondence between the Equivalence principle and the homogeneity of the universe is discussed. We show that under the Newtonian gravity, translation of co-moving coordinates in a uniformly expanding universe defines a new accelerated frame. A consistency condition for the invariance of this transformation yields the second Friedman equation. All these symmetries are lost when we modify Newton's second law and/ or the Poisson equation. For example by replacing Newton's second law with non-linear function of the acceleration, as Modified Newtonian Dynamics (MOND) suggested, the concept of relative acceleration is lost. As a consequence the homogeneity of the universe breaks. Therefore MOND which changes Newton's second law or a QUAdratic Lagrangian (AQUAL) which changes the Poisson equation are not complete theories and they should be amended to preserve the cosmological principle. Only locally could MOND be used as a toy model, but not as a global theory which should describe a universe in large scales.

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