

SIGNIFICANCE OF TENSION FOR KALUZA- KLEIN MODELS: CRITICAL REMARKS

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We clarify the problematic aspects of gravitational interaction in the weak field limit of Kaluza-Klein models. We explain why some models meet the classical gravitational tests, while the others do not. We show that variation of the total volume of the internal spaces generates the fifth force. This is the main reason of the problem. It happens for all considered models (linear with respect to the scalar curvature and nonlinear $f(R)$, with toroidal and spherical compactifications). We explicitly single out the contribution of the fifth force to nonrelativistic gravitational potentials.

In the case of toroidal compactification, we demonstrate how tension (with and without effects of nonlinearity) of the gravitating source can fix the internal space volume, resulting in the vanishing fifth force and, consequently, in agreement with the observations. It takes place for latent solitons, black strings and black branes. We also give a particular example where non-vanishing variation of the internal space volume does not contradict the gravitational experiments.

In the case of spherical compactification, the fifth force is replaced by the Yukawa interaction for models with the stabilized internal space. For large Yukawa masses, the effect of this interaction is negligibly small, and considered models satisfy the gravitational tests at the same level of accuracy as general relativity. However, gravitating masses acquire effective relativistic pressure in the external space. Such pressure contradicts the observations. We demonstrate that tension is the only possibility to preserve the dust-like equation of state in the external space. Therefore, tension plays a crucial role for the considered models.