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Coupling between the Ho\v{r}ava-Lifshitz gravity and electromagnetism

Monday 26 November 2018 16:00 (15 minutes)

We analyze the gravity-electromagnetic interaction in a pure Ho\v{r}ava-Lifshitz framework. To do so we formulate the Ho\v{r}ava-Lifshitz gravity in $4+1$ dimensions and perform a Kaluza-Klein reduction to $3+1$ dimensions. We use this reduction as a mathematical procedure to obtain the $3+1$ coupled theory, which at the end is considered as a fundamental, self-consistent, theory. The critical value of the dimensionless coupling constant in the kinetic term of the action is $\lambda = 1/4$. It is the kinetic conformal point for the non-relativistic electromagnetic-gravity interaction. In distinction, the corresponding kinetic conformal value for pure Ho\v{r}ava-Lifshitz gravity in $3+1$ dimensions is $\lambda = 1/3$. We analyze the geometrical structure of the critical and noncritical cases, they correspond to different theories. The physical degrees of freedom propagated by the noncritical theory are the transverse traceless graviton, the transverse gauge vector and two scalar fields. In the critical theory one of the scalars is absent, only the dilaton scalar field is present. The gravity and vector excitations propagate with the same speed, which at low energy can be taken to be the speed of light. The field equations for the gauge vector in the non-relativistic theory have exactly the same form as the relativistic electromagnetic field equations arising from the Kaluza-Klein reduction of General Relativity, and are equal to them for a particular value of one of the coupling constants. The potential in the Hamiltonian is a polynomial of finite degree in the gauge vector and its covariant derivatives.

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