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Geometric Justification of the Fundamental Interaction Fields for the Classical Long-Range Forces

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Abstract: Based on the principle of reparametrization invariance, the general structure of physically relevant classical matter systems is illuminated within the Lagrangian framework. In a straightforward way, the matter Lagrangian contains background interaction fields, such as a 1-form field analogous to the electromagnetic vector potential and symmetric tensor for gravity. The geometric justification of the interaction field Lagrangians for the electromagnetic and gravitational interactions are emphasized. The generalization to E-dimensional extended objects (p-branes) embedded in a bulk space M is also discussed within the light of some familiar examples. The concept of fictitious accelerations due to un-proper time parametrization is introduced, and its implications are discussed. The framework naturally suggests new classical interaction fields beyond electromagnetism and gravity. The simplest model with such fields is analyzed and its relevance to dark matter and dark energy phenomena on large/cosmological scales is inferred. Unusual pathological behavior in the Newtonian limit is suggested to be a precursor of quantum effects and of inflation-like processes at microscopic scales.

Keywords: diffeomorphism invariant systems; reparametrization-invariant matter systems; matter lagrangian; homogeneous singular lagrangians; relativistic particle; string theory; extended objects; p-branes; interaction fields; classical forces beyond electromagne

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