

General Relativity and Quantum Cosmology

Relational mechanics of shape and scale

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Relational particle mechanics models (RPM's) are useful models for the problem of time in quantum gravity and other foundational issues in quantum cosmology. Some concrete examples of scalefree RPM's have already been studied, but it is the case with scale that is needed for the semiclassical and dilational internal time approaches to the problem of time. In this paper, I show that the scaled RPM's configuration spaces are the cones over the scalefree RPM's configuration spaces, which are spheres in 1-d and complex projective spaces in 2-d for plain shapes, and these quotiented by Z_2 for oriented shapes. I extend the method of physical interpretation by tessellation of the configuration space and the description in terms of geometrical quantities to the cases with scale and/or orientation. I show that there is an absence of monopole issues for RPM's and point out a difference between quantum cosmological operator ordering and that used in molecular physics. I use up RPM's freedom of the form of the potential to more closely parallel various well-known cosmologies, and begin the investigation of the semiclassical approach to the problem of time for such models.

Comments: Just a few minor changes/references added

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