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Kinematical Vortical Effect and Gravitational chiral anomaly

Based on a general analysis of conservation laws, the duality between gravity and hydrodynamics of a relativistic quantum fluid in a flat space is shown. This duality is expressed in the equality between hydrodynamic transport coefficients and quantum corrections in curved space-time. It is shown that the gravitational chiral anomaly is dual to the axial current in the vortical and accelerated fluid, which arises in the third order of the gradient expansion. The corresponding current is a new anomalous transport phenomenon, which can be called the Kinematical Vortical Effect (KVE). The general analysis has been explicitly verified for fields with spins 1/2 and 3/2. In the case of spin 3/2, an extended Rarita-Schwinger-Adler (RSA) field theory containing an additional field with spin 1/2 is considered. Using the method of conformal three-point functions, we found the gravitational chiral anomaly in the RSA theory for the fist time, and using the Zubarev density operator, we calculated the KVE transport coefficients. The results obtained confirm the duality and demonstrate the manifestation of the cubic spin dependence of the gravitational chiral anomaly, in hydrodynamics.

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