

Relativistic Hydrodynamic Equations for Fully Degenerate Plasma

Fernando Haas¹ and Ioannis Kourakis²

¹*Instituto de Física, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil*

²*Department of Physics and Astronomy, Queens University Belfast, Belfast, Northern Ireland*

Recently there has been a strong interest in wave propagation and dynamics of nonlinear structures in relativistic degenerate plasmas described by hydrodynamic equations. Most recent publications, however, use an inconsistent modeling, in the sense that various methodological discrepancies are adopted. These often involve inclusion of a relativistic equation of state into non-relativistic fluid equations, use of manifestly incorrect relativistic formalism, or/and use of a three-dimensional equation of state for the description of (one-dimensional) wave propagation, a truly one-degree-of-freedom phenomenon [1]. We discuss these inconsistencies and present a correct relativistic hydrodynamic plasma model in the fully degenerate case. Equations of state for one, two and three spatial dimensions are presented. Appropriate analytical models for various basic plasma excitations are presented; the resulting dispersion relations are compared to those obtained by means of frequently used doubtful formulations. The non-relativistic limit is also explored. Fully nonlinear traveling wave solutions are treated through the corresponding Sagdeev-type pseudopotential.

[1] G. Manfredi, *Fields Institute Communication Series* **46**, 263 (2005).