On the inexistence of solitons in Einstein-Maxwell-scalar models

Carlos A. R. Herdeiro[1‡], João M. S. Oliveira[2†],

[1]Centro de Astrofísica e Gravitação - CENTRA,
Departamento de Física, Instituto Superior Técnico - IST, Universidade de Lisboa,
Avenida Rovisco Pais 1, 1049-001, Portugal

[2]Departamento de Física da Universidade de Aveiro and CIDMA,
Campus de Santiago, 3810-183 Aveiro, Portugal

Abstract

Two non-existence results are established for self-gravitating solitons in Einstein-Maxwell-scalar models, wherein the scalar field is, generically, non-minimally coupled to the Maxwell field via a scalar function $f(\Phi)$. Firstly, a trivial Maxwell field is considered, which yields a consistent truncation of the full model. In this case, using a scaling (Derrick-type) argument, it is established that no stationary and axisymmetric self-gravitating scalar solitons exist, unless the scalar potential energy is somewhere negative in spacetime. This generalises previous results for the static and strictly stationary cases. Thus, rotation alone cannot support self-gravitating scalar solitons in this class of models. Secondly, constant sign couplings are considered and it is established that no strictly stationary self-gravitating electromagnetic-scalar solitons exist. We use a Lichnerowicz-type argument, generalising previous results in models where the scalar and Maxwell fields are not directly coupled. The scope of validity of each of these results points out the possible paths to circumvent them, in order to obtain self-gravitating solitons in Einstein-Maxwell-scalar models.

‡ carlosherdeiro@tecnico.ulisboa.pt
† jmiguel.oliveira@ua.pt