Cristinel Stoica
Institute of Mathematics of the Romanian Academy

Advances on the problem of singularities in General Relativity

Authors: O. C. Stoica

Results concerning an extension of differential geometry and the Einstein equation to singularities are reported. These results are based mathematically on an extension of semi-Riemannian geometry which allows the definition of curvature invariants and covariant derivatives of differential forms, even when the metric becomes degenerate. It is shown that the singularities of this form allow a smooth extension of the Einstein equations, including matter fields. A cosmological model which extends the FLRW solution, turn out to have the Big-Bang singularity of this type. The metric of the stationary black hole solutions are shown to be of the type studied here (apparently their singularities were of another type, but it turns out that the standard coordinates are singular, masking the smoothness of the metric). Charged black holes, when expressed in the proposed coordinates, have the electromagnetic potential regular everywhere. Implications on the Weyl curvature hypothesis (Penrose) are presented. In addition, these singularities are accompanied by a (geo)metric dimensional reduction, which acts as a regulator for the quantum fields in the UV regime, including for quantum gravity.