Sanchis-Gual, Nicolas; **Montero, Pedro J.**; **Font, José A.**; **Müller, Ewald**; **Baumgarte, Thomas W.**

Fully covariant and conformal formulation of the Z4 system compared to the BSSN formulation in spherical symmetry. (English) Zbl 1329.83052

Sopuerta, Carlos F. (ed.), Gravitational wave astrophysics. Proceedings of the third session of the Sant Cugat Forum on astrophysics, Barcelona, Spain, April 22–25, 2014. Cham: Springer (ISBN 978-3-319-10487-4/hbk; 978-3-319-10488-1/ebook). Astrophysics and Space Science Proceedings 40, 203-208 (2015).

Summary: We have generalized a covariant and conformal version of the Z4 system of the Einstein equations by adopting a reference metric approach, that we denote as fCCZ4, well suited for curvilinear as well as Cartesian coordinates. We implement this formalism in spherical polar coordinates under the assumption of spherical symmetry using a partially-implicit Runge-Kutta (PIRK) method, without using any regularization scheme, and show that our code can evolve both vacuum and non-vacuum spacetimes without encountering instabilities. We have performed several tests and compared the Hamiltonian constraint violations of the fCCZ4 system, for different choices of certain free parameters, with these of BSSN. For an optimal choice of these parameters, and for neutron star spacetimes, the violations of the Hamiltonian constraint can be between 1 and 3 orders of magnitude smaller in the fCCZ4 system than in the BSSN formulation. For black hole spacetimes, on the other hand, any advantages of fCCZ4 over BSSN are less evident.

For the entire collection see [Zbl 1305.85002].

MSC:

83C05	Einstein's equations (general structure, canonical formalism, Cauchy problems)	Cited in **2** Documents
83-08	Computational methods for problems pertaining to relativity and gravitational theory	
83C57	Black holes	

Keywords:

Einstein equation; partially-implicit Runge-Kutta (PIRK) method; black hole

Software:

fCCZ4

Full Text: DOI

References: