Stability of marginally outer trapped surfaces and existence of marginally outer trapped tubes

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Abstract

The present work extends our short communication L. Andersson, M. Mars and W. Simon, Local existence of dynamical and trapping horizons, Phys. Rev. Lett. 95 (2005), 111102. For smooth marginally outer trapped surfaces (MOTS) in a smooth spacetime, we define stability with respect to variations along arbitrary vectors $v$ normal to the MOTS. After giving some introductory material about linear non-self-adjoint elliptic operators, we introduce the stability operator $L_v$ and we characterize stable MOTS in terms of sign conditions on the principal eigenvalue of $L_v$. The main result shows that given a strictly stable MOTS $S_0 \subset \Sigma_0$ in a spacetime with a reference foliation $\Sigma_t$, there is an open marginally outer trapped tube (MOTT), adapted to the reference foliation, which contains $S_0$. We give conditions under which the MOTT can be completed. Finally, we show that under standard energy conditions on the spacetime, the MOTT must be either locally achronal, spacelike or null.