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Challenging the standard perfect fluid paradigm JAMES O'BRIEN, Wentworth Institute of Technology — We show that the standard perfect fluid paradigm is not necessarily a valid description of a curved space steady state gravitational source. Simply by virtue of not being flat, curved space geometries have to possess intrinsic length scales, and such length scales can affect the fluid structure.We show that for the specific case of a static, spherically symmetric geometry, the steady state energy-momentum tensor that ensues will in general be of the form $T_{\mu\nu} = (\rho + p)U_\mu U_\nu + pg_{\mu\nu} + q\pi_{\mu\nu}$ where $\pi_{\mu\nu}$ is a symmetric, traceless rank two tensor which obeys $U^\mu \pi_{\mu\nu} = 0$. Such a $q\pi_{\mu\nu}$ type term is absent for an incoherently averaged steady state fluid in a spacetime where there are no intrinsic length scales, and in principle would thus be missed in a covariantizing of a flat spacetime $T_{\mu\nu}$. While it is reassuring that we find that in practice the effect of such $q\pi_{\mu\nu}$ type terms is small for weak gravity stars, for strong gravity systems their potential influence would need to be explored.

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