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Exact Solutions to Einstein's Field Equations for Static Spherically Symmetric Perfect Fluids THOMAS KIESS, self — In classical general relativity, exact solutions to Einstein's Field Equations are useful, but for static spherically symmetric perfect fluids, only a handful of their exact closed form metrics satisfy the physical boundary conditions. We derive exact solutions to Einstein's Field Equations for a static spherically symmetric perfect fluid (in 3+1 dimensions), including a physical solution. This physical metric can be cast as the line element $\mathrm{ds}^2 = -c^2 \left(\sqrt{1-x/7}\,(1+x)^{3/2} - \frac{7\beta}{192c_1}\left(11+2x-x^2\right)\right)^2 dt^2 + \frac{(1+x)}{(1-x/7)} dr^2 + r^2 d\Omega^2$, where c=the speed of light, c_1 is a constant, and $x \equiv c_1 r^2$, for $c_1 > 0$ and β satisfying $\sim 0.0616 < -7\beta/192c_1 < 1$. This physical solution used as a stellar model provides relatively large redshifts z – as large as 0.87 at the stellar surface, and as large as 4.05 in the interior. Modeling large redshift objects is of interest because their populations constrain cosmological models of dark energy. Another exact solution we derive is an unphysical one for zero mass, which can be cast as the line element $\mathrm{ds}^2 = -\left[a+br^2\right]^2 c^2 \mathrm{dt}^2 + \mathrm{dr}^2 + r^2 \mathrm{d}\Omega^2$ for constants a and b. Although values of $b \neq 0$ are unphysical, this metric is potentially interesting because it provides another classical way (apart from the introduction of a cosmological constant) to generate finite pressure everywhere in space, in a system of zero net mass.

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