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Extended Abstract

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Radial oscillations of relativistic compact stars

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The perfect fluid model has been very successful in modeling the matter content of compact stars. This is particularly the case with fermionic matter, because the perfect fluid model is able to capture properties of the quantization of fermions, such as Pauli exclusion. Static compact star solutions using perfect fluids are found by solving the time-independent Einstein field equations with a perfect fluid energy-momentum tensor. Recently there has been increased interest in compact stars made with multiple fluids. This has been motivated by the possibility that neutron stars might capture dark matter. If dark matter cannot self-annihilate (as is the case, for example, with asymmetric dark matter, it will accumulate in the neutron star. In such a scenario, dark matter can be modeled as an additional fluid in the star. There have been a number of recent studies of the properties of static two-fluid compact stars. After a compact star solution is found, one can study the effect of small perturbations to the solution. This may be done by solving a pulsation equation, which is a differential equation describing the time-evolution of the perturbation. For spherically symmetric static solutions and perturbations, the solution to the pulsation equation gives the squared radial oscillation frequency. In addition to describing radial oscillations, the squared radial oscillation frequency tells us about the stability of the star with respect to small perturbations. If the squared oscillation frequency is negative, the compact star solution is unstable. Chandrasekhar was the first to derive a pulsation equation for a compact star made of a single perfect fluid. His pulsation equation was subsequently rewritten in various ways, in some cases to facilitate numerical solutions. More recently, a pulsation equation was derived for two-fluid systems and has been used to study the stability of two-fluid stars (an alternative approach for determining the stability of two-component stars, which has been applied to boson-fermion stars, was studied. In this construction, there is a single pulsation equation. It is possible to solve the single pulsation equation in a two-fluid system, but without additional assumptions it can be difficult to do so. One such assumption is to disallow nongravitational interfluid interactions. Indeed, this assumption is made in many of the studies of two-fluid compact stars. This assumption allows the equations of motion to separate and leads to a system of coupled pulsation equations, with the same number of pulsation equations as fluids. This increase in the number of pulsation equations makes them easier to solve. In this work, I present this system of pulsation equations. I shall assume spherical symmetry and, as mentioned, allow only gravitational interfluid interactions (I make no assumptions about self-interactions). In doing this, I give a very different derivation than in a derivation made possible by my assumption of there only being gravitational interfluid interactions and a derivation in line with Chandrasekhar's original derivation for a single fluid. The system of equations I arrive at keeps the contributions from the individual fluids manifest and allows them to be easily solved for, if desired. I illustrate the use of this system of pulsation equations with one-, two-, and threefluid examples. In the next section I derive the system of pulsation equations, present one-, two-, and three-fluid examples. With three fluids there are three parameters to be determined using the shooting method: ω¯ 2, η2ð0Þ, and η3ð0Þ. It is significantly more time consuming to determine three parameters than it is to determine two parameters and I present results for only a single equilibrium solution with the solid curves plotting the equilibrium variables tx0ðr¯Þ and the dashed curves plotting the pulsation variables ηxðr¯Þ.

We investigate the dark matter impact on properties of strange quark stars, such as mass-to-radius profiles and oscillation radial modes. The dark matter particle may be a boson or a fermion. First, in the two-fluid formalism we integrate the structure equations to obtain the interior solution. Next, this solution is plugged into the equations for the perturbations to obtain the frequency radial modes and the corresponding eigenfunctions. The large separation, a good observational signature, is also computed. Author will discuss radial oscillations of neutron stars with an accurate equation-of-state without dark matter. Recent Publications: 1. G Panotopoulos and A Rincon () Charged slowly rotating toroidal black holes in the (1+3)-dimensional Einstein-power- Maxwell theory. International Journal of Modern Physics. A Rincon, E Contreras, P Barqueno, B Koch and G Panotopoulos (2018) Scale-dependent (2+1) - dimensional electrically charged black holes in Einstein-power-Maxwell theory. European Physical Journal G Panotopoulos (2018) Electromagnetic quasinormal modes of the nearly-extremal higher-dimensional Schwarzschildde sitter black hole. Modern Physics Letters G Panotopoulos (2018) Quasinormal modes of the BTZ black hole under scalar perturbations with a non-minimal coupling: exact spectrum. General Relativity and Gravitation G Panotopoulos and A Rincon (2018) Growth index and statefinder diagnostic of oscillating dark energy. Physical Review

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