# Structure and Stability of Strange and Charm Stars at Finite Temperature

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The purpose of this work [1] consists of an detailed investigation of the structure and stability of strange and charm stars at finite temperatures. It is found that temperatures $T \leq 50$ MeV modify the equation of state significantly only at energy densities that are close to $\sim 4B$, i.e., at small external bag pressures. The situation is different for the electrons since they are bound to the system by the electromagnetic interaction rather than the strong force, as is the case for the quarks. Correspondingly the electron density varies for temperatures in the range $0 \leq T \leq 50$ MeV between one and two orders of magnitude. A change of the density of electrons is accompanied by a change of their chemical potential, which, however, is smaller than $\lesssim$1 MeV. As a consequence of the weak temperature dependence of the equation of state, the bulk properties of sequences of strange stars too exhibit only a weak dependence on temperature. The quark/lepton composition of quark-star matter is determined up to those densities at which even charm-quark states become populated. We find that this takes place at densities slightly larger than $10^{17}$ g/cm$^3$. In order to fulfill the condition of electric charge neutrality, there is only little need for electrons. Muons are completely absent in strange-star matter, and become populated only at densities larger than the threshold density of charm quarks.

Of crucial importance for the existence of nuclear crusts on the surfaces of bare strange stars is the existence of a Coulomb barrier associated with the difference of the electrostatic potential at the surface and the base of the crust. It is found that finite temperatures lead to a considerable reduction of the Coulomb barrier, which favors the tunneling of ions (atomic nuclei) bound in the nuclear crust toward the strange star surface. In fact, the electrostatic potentials at the surface of a hot strange star and at the base of its inner crust may even become equal at temperatures that are typical for newly formed pulsars, $T \sim (30-50)$ MeV. Thus, the Coulomb barrier, which prevents the ions in the crust from coming into contact with the star's strange matter core, disappears and consequently conversion of confined baryonic matter into strange matter is not prohibited any longer. Therefore, we conclude that hot strange stars are unlikely to possess nuclear crusts as long as their temperatures are larger than about 5 MeV, depending on the value of the crust's electrostatic potential at its base.

Another important topic of this investigation consists of performing a stability analysis of quark-matter stars against radial oscillations. It is found that the fundamental eigenmode passes through zero at the density of the most massive strange star. This eigenmode is positive at all densities smaller than this one. Thus, strange stars are stable against radial oscillations. The situation is different for all quark stars having central densities larger than the maximum-mass strange star. For all such configurations the fundamental mode is found to be unstable. More than that, going to higher and higher central star density leads to the successive excitation of higher-lying eigenmodes. We thus arrive at the very important conclusion that no quark-matter stars can exist in nature other than the hypothetical strange stars. Specifically, this rules out the possible existence of charm-quark stars.

## References

[1] Ch. Kettner, F. Weber, M. K. Weigel, and N. K. Glendenning, Phys. Rev. **D51** (1995) 1440