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Review

Strange quark matter and compact stars

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Abstract

Astrophysicists distinguish between three different kinds of compact stars. These are white dwarfs, neutron stars, and black holes. The former contain matter in one of the densest forms found in the Universe which, together with the unprecedented progress in observational astronomy, makes such stars superb astrophysical laboratories for a broad range of most striking physical phenomena. These range from nuclear processes on the stellar surface to processes in electron degenerate matter at subnuclear densities to boson condensates and the existence of new states of baryonic matter—such as color superconducting quark matter—at supernuclear densities. More than that, according to the strange matter hypothesis strange quark matter could be more stable than nuclear matter, in which case neutron stars should be largely composed of pure quark matter possibly enveloped in thin nuclear crusts. Another remarkable implication of the hypothesis is the possible existence of a new class of white dwarfs. This article aims at giving an overview of all these striking physical possibilities, with an emphasis on the astrophysical phenomenology of strange quark matter. Possible observational signatures associated with the theoretically proposed states of matter inside compact stars are discussed as well. They will provide most valuable information about the phase diagram of superdense nuclear matter at high baryon number density but low temperature, which is not accessible to relativistic heavy ion collision experiments.

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Keywords: Nuclear matter; Strange matter; Quarks; Phase transitions; Neutron stars

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1. Introduction

It is often stressed that there has never been a more exciting time in the overlapping areas of nuclear physics, particle physics, and relativistic astrophysics than today. This comes at a time where new orbiting observatories such as the Hubble Space Telescope, Rossi X-ray Timing Explorer (RXTE), Chandra x-ray satellite, and X-ray Multi Mirror Mission (XMM) have extended our vision tremendously, allowing us to see vistas with an

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