Superdense QCD Matter and Compact Stars

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Superdense QCD Matter and Compact Stars

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This book is dedicated to the memory of Victor Ambartsumyan and Gurgen Sahakian who pioneered the field of superdense matter and compact stars in Armenia.

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Foreword

In the early thirties of the last century Baade and Zwicky conjectured in their studies of supernova explosions that supernovae represent a transition from ordinary stars to compact objects, whose size is an order of magnitude smaller than the size of a white dwarf. At that time it was already known that the atomic nucleus consists of neutrons and it was clear that the density of the remnant objects must be of the same order as the nuclear density. Baade and Zwicky predicted that a supernova explosions will result in objects composed of closely packed neutrons (neutron stars). Prior to the beginning of the second World War (1939) a number of theoretical works by Landau, Oppenheimer, Volkoff and Snider showed, that indeed objects could exist with sizes about 10 km and masses about a solar mass. The density in these objects is about the nuclear saturation density and they basically consist of neutrons with a small amount of protons and electrons. The studies of neutron stars were subsequently stopped most likely due to the engagement of the nuclear scientists in the development of the nuclear bomb both in the West and the East.

After a 20 year break V. H. Ambartsumyan and G. S. Sahakian initiated an intensive research on compact objects during the 1960s in Armenia. In their pioneering work on compact stars they showed, that with increasing density, hyperons appear in nuclear matter and thus a neutron star at high densities consists predominantly of hyperons. Thus, as the density increases more and more heavy particles become stable. After the discovery of quarks as basic constituents of hadrons (including hyperons) the ideas of compact stars with quark cores or stars entirely composed of quark matter were presented.

Another important result obtained by Armenian physicists during the 1960s, is the observation that the mass of superdense objects is limited and is about several solar masses. This conclusion made in the beginning of the 1960s, actually proved the statement that the stars with masses above several solar masses turn into black holes at the end of their evolution. These works have stimulated intensive studies of black holes which are continued until now.

The problem of rotation of neutron stars in the framework of General Relativity Theory was solved before the discovery of pulsars and the important contribution of the Armenian scientists in this work is well documented. With all

the theoretical work done on compact objects by the late 1960s, the fortuitous discovery of pulsars in 1968 was both gratifying and encouraging, however this was not a surprise to most of the practitioners in this field. The scientists in Armenia continued contributing to the investigations of pulsars and compact objects since then; their work includes studies of the equation of state of matter, strong magnetic fields, superfluid and superconducting properties of neutrons and protons in neutron stars, strange neutron stars, dynamics of pulsar rotation and other phenomena related to superdense objects.

The organization of this conference on superdense QCD matter in compact stars in Yerevan in 2003, the year in which the founders of the Armenian scientific school V. H. Ambartsumyan and G. S. Sahakian would become 95 and 85 years old, was the homage to them and all the Armenian scientists, who have made contributions to the investigation of superdense stellar matter.

This conference which brought together leading experts in the fields of dense matter as well as compact star physics from the Eastern and the Western hemispheres was made possible due to the support by the NATO Science programme which is gratefully acknowledged.

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