AN INTRODUCTION TO THE THEORY OF INTERNAL STRUCTURE OF SUPERMASSIVE COMPACT CELESTIAL BODIES

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Abstract. Different in principle from the contemporary standard black hole accretion models, a new approach to the understanding of the internal structure of highly compact stationary supermassive celestial bodies has been worked out. The equations of equilibrium configurations of baryonic protomatter (ECBP) have been discussed. In a particular case of ideal degenerated neutron gas in absence of a process of inner distortion of the space and time, it has been shown that the theory suggested by Ter-Kazarian (1989e) leads to the same results as those obtained by Oppenheimer and Volkoff (1939) based on Einstein's theory. The numerical integration of equations of ECBP in the most simple case of equilibrium single-component configurations of degenerated ideal gas of neutrons in a presence of one-dimensional space-like inner distortion of space-time continuum is carried out. It has been shown that the stable stationary supermassive cores are formed in the central parts of the considered configurations. As the models of active galactic nuclei (AGNs) one has considered only the configurations that consisted of these cores surrounded by accretion disks. The fundamental difference from the standard black-hole accretion models is the fact that the central cores are in a stable equilibrium state with certain radial distributions of density and pressure and with a number of integral characteristics. The significant effect of metric singularity cut-off has been established, due to the action of which a singularity of metric ceased to be significant. The numerous integrations have also revealed the other fact of great importance, the presence within the outlined theory of a rigorous restriction on the upper limit of possible values of total masses of considered equilibrium configurations, which is to be $M \leq 3.5 \times 10^8 M_\odot$. In the last section one has proceeded to the direct modelling of concrete AGNs (for 61 sources), the whole point of which comes to the solving of the inverse problem. The results of all calculations that have been carried out in the present work are summarized in Tables I–VII and represented by means of numerous figures. Finally, one should emphasize the important fact of the existence of BL Lac objects OJ 287, 3C 66A, and B2 1308 + 32, the observed time-scale for flux variations of which are inconsistent with contemporary black hole accretion models. The case is quite different within the scope of the suggested theory. It seems that a decisive significance for these objects has the action of metric singularity cut-off effect. Due to this their observed sizes are less than the sizes of corresponding spheres of the event horizon. This may serve as a further indication that the suggested theory is preferable to the standard models.

1. Introduction

There are sufficiently large numbers of observational data in astrophysics which prove the presence in the Universe of highly compact supermassive formations existing in the stable stationary state for a long time, compared to the age of the Universe. The important astrophysical phenomenon, such as the active galactic nuclei (AGNs) with super-Eddington luminosity, is related to such objects. It is generally acceptable to describe AGNs by means of standard black hole accretion models (Wiita, 1982; Rees, 1984; Band and Malkan, 1989; Impey, 1988). In the standard scenario the central engine is a massive black hole into which a matter accretes through an accretion disk.
According to conventional physics, the massive black holes should exist in these celestial bodies as well as in the nuclei of all galaxies that have ever experienced a violently active phase, just because of their more efficient power supply. A black hole has been formed as an almost inevitable endpoint of the gravitational collapse of a large fraction of total mass of supermassive configuration, which took place after the entire burning of the whole amount of spared intrinsic energy. The standardized black hole has been characterized by just two parameters – mass and spin – and described by the Kerr metric. The black holes are fueled steadily via the thick accretion disks. Such evolutionary processes of accretion onto massive black holes as the prime energy sources have immense emissive power. The idea that they can provide observed super-high luminosity of AGNs has become widely acknowledged among the astrophysicists.

The fact that accretion processes really takes place in AGNs seems to be proven for certain by many observations. Within respect to standard models, one should note that such an approach to the understanding of the physics of superdense equilibrium configurations, based on the main idea of black holes, suffers from some grave shortcomings. First among them – the fate of a collapsing sphere, with respect to the proper coordinate system that is being used, remains indefinite. Due to such unbelievably extreme conditions, the theory breaks down inside the black hole where static observers cannot exist, because they are inexorably drawn into the central singularity, lacking the possibility of calculation of corresponding integral characteristics of AGNs, particularly the total mass, radius, etc. But the main deficiency is the fact that the observed time-scales for flux variations of some objects are inconsistent with contemporary black hole accretion models. That is, on the basis of the diagram of the minimum variability time-scale against the bolometric luminosity for 60 sources it has been shown that few BL Lac objects – B2 1308 + 72, 3C 66A, OJ 287, A0 0235 + 16 and quasars – 3C 345, 3C 446, 3C 454.3, LB 9743 remained in the forbidden zone (particularly the initial three of them) (Bassani et al., 1983; Bassani and Dean, 1983). Therefore, the creation of new viable theoretical constructions for the explanation of an abundant specter of observational data, especially for an understanding of physics of the celestial bodies considered above, is a problem of paramount importance.

An alternative approach to the understanding of the internal structure of these objects is outlined by Ter-Kazarian (1989a, b, 1990), which makes use of a basic assumption that supermassive stable cores are existing in the central parts of them. Of course, it is impossible to obtain the solution of this problem within the scope of well-established and generally accepted contemporary theoretical conceptions, because of the fundamental difficulties encounters: (1) the presence of gravitational radius as a lowest limit for valid radius of any gravitating mass at hydrostatic equilibrium; (2) the problem of hydrostatic equilibrium of such a configuration under the condition of a high increase of its total mass.

Actually, general relativity imposes a rigorous restriction on a possible upper limit of density. For example, a condensed matter of order of magnitude of galaxy mass should have radius \( R < (9/8)R_g \approx 0.01 \text{ pc} \) and density \( \rho < 2 \times 10^{-6} \text{ g cm}^{-3} \) \( (R_g \text{ is the gravitational radius}) \).