

On the nature of the compact condensations at the centre of galaxies

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Abstract There are many observational evidences for the existence of massive compact condensations in the range $10^6 - 10^{10} M_{\odot}$ at the core of various galaxies and in particular in the core of High Energy Gamma Ray emitting galaxies. At present such condensations are commonly interpreted as Black Holes (BHs). However, we point out that while such Black Hole Candidates (BHCs) must be similar to BHs in many respects they, actually, can not be BHs because existence of Black Holes would violate the basic tenet of the General Theory of Relativity (GTR) that the *worldline of a material particle must be timelike at any regular region of spacetime*. On the other hand general relativistic collapse of massive bodies should lead to Eternally Collapsing Configurations (ECOs). While ECOs may practically be as compact as corresponding BHs, they will have a physical surface. Also while BHs do not have any intrinsic magnetic field ECOs may have strong intrinsic magnetic field. We point out that despite many claims actually there is no real evidence for the “Event Horizon” (EH) of supposed BHs and on the other hand, there are tentative evidence for the existence of strong magnetic field in several BHCs (or ECOs). The presence of such intrinsic magnetic field may render the task of explaining high energy radiation phenomenon in many Active Galactic Nuclei easier.

Key words: Compact Objects, No Black Holes

1. Introduction

This conference GAME 2001 is aimed at understanding the High Energy Astrophysics associated with gamma ray sources and for the specific case of point sources it is important to know the nature of the central engine accelerating the particles responsible for gamma production. One of the rules of this GAME so far has been to call all cold compact objects having mass higher than $3-4 M_{\odot}$ as “Black Holes” (BHs). But we would appeal to change this rule. While we make this appeal, we must say that, in the existing paradigm, there are, apparently, many good reasons to believe that all such massive

compact condensations are BHs or singularities. We know that all stars do exhaust their nuclear fuel at a certain finite time and therefore must start collapsing due to self-gravity. Low mass stars, following gravitational collapse, end up as a class of compact objects called White Dwarfs (WDs) where the gravitational pull is counteracted by degenerate electron pressure of the stellar material. But Chandrasekhar taught us that there is an upper limit on the mass of WDs (which, at the time of its proposition, sounded as incredible as the present appeal for a new “rule”). This implied that more massive stars, at the exhaustion of their fuel, must collapse to a stage beyond the WD one. Now we know that more massive stars may collapse to deeper potential wells supported by the degeneracy pressure of their nucleons. Such configurations are broadly referred to as Neutron Stars (NSs) although such configurations could be Strange Stars or other cold baryonic condensations. We also know that NSs do have an upper limit on their masses and in the context of *standard* Quantum Chromodynamics, an absolute upper limit could be $M_{ov} \sim 4 - 5M_{\odot}$. This again means that very massive stars must collapse to a stage beyond the NSs stage which is generally called as BHs. Atleast for the spherical case, this seems to be obvious because of the following (incorrect) thinking: Let a given star has initial *radius parameter* R_i . Then suppose the star collapses with a mean local speed V_m . Then, as a matter of geometry, it might appear that, the star would collapse to a geometrical point, a singularity, in a comoving proper time R_i/V_m . While this is true in Newtonian gravitation, this picture is actually not strictly correct in GTR because R_i is *not the physical radial depth of the star* eventhough $2\pi R_i$ is its circumference! If r is the comoving radial coordinate, and g_{rr} is the corresponding metric coefficient (see below), the physical or proper or locally measured radial depth of the star is somewhat like $l \sim \int_0^R \sqrt{-g_{rr}} dr$. In a dynamical case l is not properly defined because g_{rr} is ever changing, yet one can obtain a definite value for l in the limit $R \rightarrow 0$. Since $-g_{rr} \rightarrow \infty$ in the same limit, it is probable that l might blow up. And we have found that this is indeed the case (Mitra 1998, 2000). As the star tries to collapse to deeper and deeper potential well, the grip of gravity stretches the physical space more and more. And as, eventually, the space stretching tidal gravity (components of the Ricci Tensor) tends to become infinite, *the inner or physical radial space becomes infinite too!* Since by principles of relativity V_m is always finite the collapse never terminates (in a finite proper time)! As an oberver sitting on the surface of the star tries to chase its centre, the chase becomes longer and longer like a Xeno’s paradox. The observer never reaches that “geometrical point” and simultaneously he too as a participant in this spacetime game becomes of infinite proper length. Now compare this with the popular folk lore of an observer/“astronaut” falling into a supposed BH or consider the situation of a collapse when the star would indeed become a (finite mass) BH. Here the observer is supposed to reach and get crushed in a geometrical point in a finite proper time. But here too, the proper length of the observer becomes infinite. But how does the *observer of infinite proper length stay put in a point?* There is no answer to such ludicrous incongruities in the BH paradigm and a self-consistent answer can be found only in terms an ECO. Technically, this implies that, *for isolated bodies* GTR is singularity free! Since our discussion specifically uses isolated bodies with definite boundary condition, this result cannot be extended to the Universe or in other words, our work does not rule out the “Big Bang” singularity.

In order to appreciate our result, at the very outset, it is necessary to distinguish between the concepts of *gravitational mass* and baryonic mass. The mass-energy of a nucleus is less than the sum of the masses of the individual nucleons because of the (negative) attractive nuclear Binding Energy (or Mass Defect). Similarly, in the simplest case, the net mass energy or the gravitational mass of a star M (as perceived by a distant observer) is less than the sum of rest masses of its individual baryons (M_0): $M = M_0 - B.E.$. Long back, Zeldovich and Novikov (1971) conceived of a tightly packed self-gravitating configurations of baryons where the $B.E. = M_0$. Obviously, in such a case, the gravitational mass of the system would be zero $M = 0$! Even much before this Harrison et al. (1965) postulated that for a system of self-gravitating baryons, *there exists a final state where $M = 0$!* To appreciate such ideas first one has to understand that as a self-gravitating system undergoes gravitational compression, it emits radiation and therefore the value of M keeps on decreasing. Now during collapse, the value of R of course decreases and $R \rightarrow 0$. But how does the ratio, $\alpha = 2GM/Rc^2$ would change during this process. In Newtonian gravity, $M = M_i$ is constant and α increases relentlessly; for $M = 1M_\odot$, α becomes unity at $R = 3$ km, and for any value of M eventually $\alpha = \infty$ at $R = 0$. Since our common sense is governed by Newtonian physics, in the context of GTR too, we take it for granted that α would behave in more or less the same (Newtonian) fashion even though M may be changing. It is this Newtonian common sense by which the assumption of formation of a “trapped surface” during a GTR collapse is taken for granted. Nevertheless, we have found that *this common sense* is incorrect and GR does not allow existence of trapped surfaces and BHs (Mittra 2000). While we say this, it may seem that the present speaker is an absolute loner in this respect. But it is not so:

First it is well known that initially most of the founder fathers of GR considered the idea of a BH to be unphysical, some of the prominent names here are Schwarzschild, Weyl, Eddington, Rosen and most importantly Einstein (1939) himself. Interestingly and surprisingly, the conventional GR solution for the spacetime around a point mass, which is supposed to consolidate the concept of a BH, is not due to Schwarzschild! On the other hand this conventional solution is due to Hilbert (point mass sitting at $R = 0$)! In the original Schwarzschild solution (whose English translation has recently been made by Antoci and Loinger (1999)), in a trivial manner, there is no EH and no BH, because here the “point mass” is sitting *not* at $R = 0$, but at $R_* = 0$ where

$$R = [R_*^3 + (2GM/c^2)^3]^{1/3} \quad (1)$$

The EH $R = R_g = 2GM/c^2$ corresponds, in original Sch. picture, to $R_* = 0$, the origin of the coordinate system. Thus there is no finite EH and no spacetime beneath $R = 2GM/c^2$. Following this cue, Loinger (Univ. of Milan) (1999, 2000), Antoci and Leibscher (Univ. of Padova, Italy) (2001), Zakir (Tashkent) (1999), Abrams (Canada) (1989) have exterted that there are no BHs in GR. On the other hand, Leiter and Robertson (Univ. of South Okalohoma) (2001), on the basis of a modified form of GR, have shown that there may not be BHs. But my approach to the problem has been quite different. In the following, let me sketch the reasons why there can not be any finite mass BHs (henceforth $G = 1$).

2. Test Particle Radially Falling on a BH

We know from Sp. Relativity, that for any event, the associated spatial coordinate (\vec{R}) and time (t) can be amalgamated as a spacetime interval in a fictitious 4-D spacetime ($s^2 = c^2t^2 - \vec{R}^2$). An infinitesimal interval “metric” is $ds^2 = c^2dt^2 - d\vec{R}^2$. In a spherically symmetric case, for a particle on a radial motion, $\vec{R} = R$ and $ds^2 = c^2dt^2 - dR^2$. The foundation of Sp. relativity lies on the tenet that for a material particle $ds^2 > 0$ (Worldline is Timelike) and for massless particles like photons $ds^2 = 0$ (Worldline is Null). The above tenets are equivalent to the more popular tenet that “the speed of a photon is always fixed $V = c$ while the former condition means that “the speed of a material particle is always less than c ”. This is so because, it can be seen that

$$ds^2 = c^2dt^2[1 - V^2/c^2] \quad (2)$$

where the speed of the particle as measured by the given observer is $V = dR/dt$ (for the radial case). Thus $ds^2 > 0$ implies $V < c$ and $ds^2 = 0$ implies $V = c$. Since, by Principle of Equivalence, locally, GR reduces to Sp. Relativity even within a supposed BH or EH, in GR too, for a material particle, always, $ds^2 > 0$ and locally measured speed of a material particle, as measured by any observer, must be less than c (at a singularity, it is possible that $ds^2 = 0$ and $V = c$).

3. Spherically Symmetric Gravitational Field

Any spherical gravitational field may be expressed, in terms of general time coordinate x_0 and radial coordinate x_1 as

$$ds^2 = g_{00}dx_0^2 + g_{11}dx_1^2 - R^2(d\theta^2 + \sin^2\theta d\phi^2) \quad (3)$$

Here R is the *Invariant* Circumference Coordinate (a scalar). Since, we shall deal with only radial worldlines with $d\theta = d\phi = 0$, our effective metric will be

$$ds^2 = g_{00}dx_0^2 + g_{11}dx_1^2 \quad (4)$$

Following Landau & Lifshitz (1985), any general metric involving x_0 (time coordinate) and x_1 (radial coordinate) can be rewritten as

$$ds^2 = g_{00}dx_0^2[1 - V^2] \quad (5)$$

where

$$V \equiv \frac{\sqrt{-g_{11}dx_1}}{\sqrt{g_{00}dx_0}} = dl/d\tau \quad (6)$$

Here we take speed of light $c = 1$ (also $G = 1$) and $d\tau$ is element of proper time. It is easy to see that Eq.(5) is the GTR generalization of Eq.(2). If there are spacetime cross terms (i.e, rotation) in Eq.(3), Eqs.(5) and (6) needs to be modified, but here we are not interested in such a case.

For the spacetime around a Sch. BH (SBH) (actually Hilbert BH), the radial variable happens to be same as R , i.e, $x_1 \equiv R$. It is a known result that in this coordinate, the speed of a test particle on the EH becomes exactly equal to the speed of light, $V = c = 1$. Had Eq.(5) been logically pursued in the past, it would have been taken as a pointer for the non existence of BHs because as my previous speaker correctly exerted (Chakrabarti 2001), the speed of a test particle on the EH must be $V = c = 1$. One natural question here could have been, "if the speed becomes already c at the EH will the speed not exceed c once the particle crosses it?" But such physical questions are a taboo as far as modern research in GTR is concerned and such a questioner would be seen as an odd man out, a person cutoff from the profound and modern BH research (though by principle of equivalence GR always reduces to Sp. Rel. locally, in a free falling frame, and one can should always be able to deal with physical quantities like speed, acceleration and differential acceleration or components of Ricci Tensor). There are several apparent reasons and excuses to not to even pose this question. Some of scientific excuses amongst them could be, (i) The external Sch. coordinate system breaks down inside the EH and (ii) the geodesic, nevertheless remains timelike even when the particle is on the EH. As to the second assertion, recall that, for the external Sch. metric, $g_{00} = 1 - 2M/R = 0$ on the EH, further dx_0 is an infinitesimal (not ∞) and therefore, one can see from Eq. (5) that as $V = 1$ $ds^2 = 0$. In other words the second assertion is incorrect on the EH. We have obtained this conclusion even without introducing any V at all in the problem (Mitra 2000, 2001).

To tackle the former argument, one can move on to the Kruskal coordinates which is believed to correctly describe the entire spacetime associated with a SBH. Here again, it has been found that, the speed of a test particle as measured by Kruskal coordinates becomes equal to the speed of light. Further, using the form of the metric in terms of Kruskal coordinate, it has been shown that the geodesic associated with its motion becomes null at $R = 2M$ (Mitra 2000, 2001). It must be so because value of ds^2 is independent of the coordinates used. Although, now, the *believers* in BH hypothesis really have no argument left to justify their faith, most of them would just tend to ignore and forget the whole matter quietly! There is an interesting physical reason why the validity of the result $V = c$ (in Sch. coordinates) cannot be shrugged off with the pretext of a "coordinate singularity" on the EH: Recall the Sp. Rel. velocity addition law for two speeds: $V = (V_1 + V_2)/(1 + V_1V_2)$. Once either or both of V_1 and $V_2 \rightarrow 1$, it follows that the resultant velocity $V \rightarrow 1$. Thus once a given observer perceives a speed to be equal to c all other observers too perceive it to be c ! Although, in GTR, velocity addition law is different, this basic result remains unchanged there and this is the reason that in GTR too, *all observers measure the same speed for light* and nothing can exceed it. The physical implication of the fact that $ds^2 = 0$ (rather than > 0) at $R = 2M$ is that the EH is the true singularity and not a mere "coordinate singularity". The only true singularity in the problem is, however, the central singularity. These two singularities merge when the radius of the EH is zero, i.e, $2M = 0$. Thus if one insists for a BH, mathematically its mass must be $M = 0$, a possibility considered previously by many authors.

There is yet another direct proof that the EH is the true central singularity. Like 4-velocity $u^i = dx^i/ds$, one can also define 4-acceleration a^i . The norm of any 4-vector is a scalar and must be non-singular at a mere coordinate singularity (the norm of u^i

is $u = \sqrt{-u^i u_i} = c$. One finds that the norm of 4-accel. is (Abrama 1989, Antoci and Leibsch 2001, Mitra 2001)

$$a = \sqrt{-a^i a_i} = \frac{M}{R^2 \sqrt{1 - 2M/R}} \quad (7)$$

Note that not only does a blow up at the EH $R = 2M$, had there been a spacetime beneath the EH, a would have become imaginary. a being a scalar is coordinate independent and in this case measurable. This doubly confirms our result that there can be no EH and no BH unless its mass is trivially zero. And when we realize that in GR, for *isolated singularities* or “point masses”, one must have $M = 0$, we see that the original Sch. solution becomes synonymous with the conventional Sch. (Hilbert) solution (Mitra 2001).

4. Spherical Gravitational Collapse

It follows from the most general formalism of spherical gravitational collapse (Mitra 2000 and ref. therein) that the integration of the 0, 0 component of the Einstein equation leads to a constraint

$$\Gamma^2 = 1 + U^2 - 2GM(r)/R \quad (8)$$

where $M(r)$ is the gravitational mass enclosed by a shell with $r = r$. Here the parameters $\Gamma = \frac{dR}{dt}$; $U = \frac{dR}{dr}$, so that, by using Eq.(6), we have $U = \Gamma V$ By inserting this relation in Eq.(8), and by transposing, we find,

$$\Gamma^2(1 - V^2) = 1 - 2GM(r)/R \quad (9)$$

Now it follows from Eq.(5) that if $1 - V^2$ is considered positive so is Γ^2 , but if it is assumed to be negative again so will be Γ^2 (Mitra 2001). This means that whether we interpret V as the local speed or not, the LHS of the above Eq. is always positive, so that

$$\frac{2GM(r)}{R} \leq 1; \quad \frac{R_g}{R} \leq 1 \quad (10)$$

On the other hand, the condition for formation of a “trapped surface” is that $2GM/R > 1$. Thus we find that, in spherical gravitational collapse *trapped surfaces do not form*. If the collapse process indeed continues upto $R = 0$, in order that the foregoing constraint is satisfied, we must have $M(r) \rightarrow 0$ as $R \rightarrow 0$, a conclusion we have already obtained from several considerations (Mitra 2000). It is widely believed that by studying the problem of the collapse of the most idealized fluid, i.e, a “dust” with pressure $p \equiv 0$ and no density gradient, Oppenheimer and Snyder (OS) (1939) explicitly showed that finite mass BHs can be generated. We have discussed in detail (Mitra 2000) that this perception is completely incorrect. For the sake of brevity, we would like to mention here

about the Eq.(36) of OS paper which connects the proper time T of a distant observer with a parameter $y = \frac{R}{2GM}$ (at the boundary $r = r_b$) through the Eq.

$$T \sim \ln \frac{y^{1/2} + 1}{y^{1/2} - 1} + \text{ other terms.} \quad (11)$$

In order that T is definable, the argument of this logarithmic term must be non-negative, i.e, $y = \frac{R}{2GM} \geq 1$, or, $\frac{2GM}{R} \leq 1$, which is nothing but our Eq.(9). Thus even for the most idealized cases, trapped surfaces are not formed. Hence there are no BHs (of finite mass). However, one can still legitimately wonder, if one starts with a dust of finite mass M , and if the dust does not radiate, why the condition $2GM/R > 1$ would not be satisfied at appropriate time? The point is that since for a dust $p = 0$, dust is really not a fluid, a (spherical) dust is just a collection of incoherent finite number of N particles distributed symmetrically. If so, there are free spaces in between the dust particles and which is not the case for a "continuous" fluid. Therefore although the dust particles are symmetrically distributed around the centre of symmetry, in a strict sense, the distribution is not really isotropic. Then the assembly of *incoherent* dust particles may be considered as a collection of $N/2$ symmetric pair of particles. In GTR, a pair of particles accelerate each other and generate gravitational radiation unmindful of the presence of other *incoherent* pairs. Therefore, the gravitational mass of an accelerating dust is really not constant! In contrast a physical spherical fluid will behave like a coherent single body with zero quadrupole moment and will not emit any gravitational radiation.

5. Summary and Discussions

From several independent approaches and from most basic premises, our work has shown that GTR does not allow existence of BHs. The immediate question would be then what is the true nature of the observationally discovered BH candidates (BHC). Our work suggests that continued collapse of very massive objects continues indefinitely because *the ever increasing curvature of spacetime (Ricci Tensor) tends to stretch the physical spacetime to infinite extent*. Hence such objects have been called Eternally Collapsing Objects (ECO). If in a given epoch the gravitational mass of a BHC/ECO is M , its circumference radius R can be arbitrary close to its Sch. radius $R_g = 2GM/c^2$ without ever becoming less than R_g , i.e, $R \geq R_g$. For practical purposes such objects are as compact as a supposed BH and they would satisfy many of the "operational definitions" of BHs. For instance, my previous speaker (Chakrabarti 2001) asserted that Galactic BHCs show a hard power law X-ray component going well beyond 100 keV. He explained that such a hard X-ray tail may be understood as direct Compton upscattering of seed photons by the electrons of the relativistically moving plasma accreting on a BHC. He pointed out that for accretion onto a NS, the speed of the plasma is smaller, the electrons are less energetic, and such a hard power law tail cannot be expected there. For a NS accretion, the maximum speed of the plasma is $V \approx 0.5c$ and the corresponding Lorentz factor is paltry ~ 1.1 . So the plasma is hardly relativistic and indeed such a hard power law may not be generated there (by the assumed process). On the other hand, Chakrabarti requires a value of $\gamma \sim 1.5 - 1.6$ for generating the hard X-rays. Recall here

that the EH is characterized by a gravitational redshift $z = \infty$ and matter falling on it acquires a value of $\gamma = \infty$. Also recall here that if the gravitational surface redshift of the compact object is z , then for free fall of plasma, one has $\gamma = 1 + z$. So assuming that Chakrabarti's model is indeed correct, the observation of a hard X-ray tail does not necessarily prove the existence of BHs (i.e, $z = \infty$), but, on the other hand, it simply indicates the existence of objects whose value of z is reasonably above 0.6. So an ECO with $z < 2$ should be sufficient to explain this observation. Such BHCs or ECOs with finite z need not always be static and cold, they need not represent stable solutions of equations for hydrostatic balance. They may be collapsing with substantial local speed V , (which this work cannot predict) but the speed of collapse perceived by a distant observer (V_∞) would approximately be lower by a factor of $(1 + z)^2$. Since V is finite ($< c$) and eventually $z \rightarrow \infty$, the ultimate value of $V_\infty \rightarrow 0$. So it is likely that even for accurate measurements (which might be possible in remote future) spanning few years, an *isolated* ECO may appear as a "static" object. The value of R for an accreting ECO would decrease even more slowly. Thus gravitational collapse of sufficiently massive bodies should indeed result in objects which could be more compact than typical NSs ($z > \sim 0.1$). It is found that, if there are anisotropies, in principle there could be static objects with arbitrary high (but finite) z (Dev and Gleiser 2000). Even within the assumption of spherical symmetry, non-standard QCD may allow existence of cold compact objects with masses as large as $10M_\odot$ or higher (Miller et al. 1998). Such stars are called Q-stars (not the usual quark stars), and they could be much more compact than a canonical NS; for instance, a stable non rotating Q-star of mass $12M_\odot$ might have a radius of ~ 52 Km. This may be compared with the value of $R_{gb} \approx 36$ Km of a supposed BH of same mass. And, in any case, when we do away with the assumption of "cold" objects and more importantly, staticity condition there could be objects with arbitrary high z .

There is another line of argument for the having found the existence of EHs in some BHCs (Garcia et al. 2001). At very low accretion rates, the coupling between electrons and ions could be very weak. In such a case most of the energy of the flow lies with the ions, but since radiative efficiency of ions is very poor, a spherical flow radiates insignificant fraction of accretion energy and carries most of the energy towards the central compact object. Such a flow is called Advection Dominated Flow (ADAF). If the central object has a "hard surface", the inflow energy is eventually radiated from the hard surface. On the other hand, if the central object is a BH, the flow energy simply disappears inside the EH. For several supermassive BHCs and stellar mass BHCs, this is claimed to be the case. But there could be several caveats in this interpretation:

(i) The observed X-ray luminosities for such cases are usually insignificant compared to the corresponding Eddington values (by a factor 10^{-5} to 10^{-7}). Such low luminosities may not be due to accretion at all. At least in some cases, they may be due to Synchrotron emission. Recently, Robertson (1999) and Robertson and Leiter (2001) have attempted to explain the X-ray emission from several BHCs having even much higher luminosities as Synchrotron origin. Vadawale, Rao and Chakrabarti (2001) have explained one additional component of hard X-rays from the micro-quasar GRS1915+105 as Synchrotron radiation. The centre of our galaxy harbours a BHC, Sgr A*, of mass $2.6 \times 10^6 M_\odot$. The recent observation of $\sim 10 - 20\%$ linear polarization from this source has strongly

suggested against ADAF model (Agol 2000). On the other hand, the observed radiation is much more likely due to Synchrotron process (Agol 2000). In fact, even more recently, Donato, Ghisellini & Tagliaferri (2001) have shown that the low power X-ray emission from the AGNs are due to Synchrotron process rather by accretion process.

(ii) The x-rays if assumed to be of accretion origin, could be coming from an accretion disk and not from a spherical flow.

(iii) Even if the X-rays are due to a spherical accretion flow, not in a single case, we have robust independent estimate of the precise accretion rate.

(iv) Munyaneza & Viollier (2001) have claimed that the accurate studies of the motion of stars near Sgr A* are more amenable to a scenario where it is not a BH but a self-gravitating ball of Weakly Interacting Fermions of mass $m_f > \sim 15.9$ keV. Recall here that the Oppenheimer - Volkoff mass limit may be expressed as

$$M_{OV} = 0.54195 M_{Pl}^3 m_f^{-2} g_f^{-1/2} = 2.7821 \times 10^9 M_{\odot} (15 \text{keV}/m_f)^2 (2/g_f)^2 \quad (12)$$

where $M_{Pl} = (\hbar c/G)^{1/2}$ is the Planck mass and g_f is the degeneracy factor. With a range of $13 < m_f < 17$ keV, these authors point out that the entire range of supermassive BHCs can be understood. Bilic (2001) has also suggested that the BHCs at the centre of galaxies could be heavy neutrino stars. Svidzinsky (2001) has suggested that atleast some of the BHCs in the blazars could be heavy bosonic stars. Note that the progenitors of the ECOs or BHCs must be much more massive (and larger in size) than those of the NSs. Then it follows from the magnetic flux conservation law that BHCs (at the galactic level) should have magnetic fields considerably higher than NSs. It is also probable even when they are old, their diminished magnetic fields are considerably higher than 10^{10} G. In such cases, BHCs will not exhibit Type I X-ray burst activity. There may indeed be evidence for intrinsic (high) magnetic fields for the BHCs (Roberson 1999, Robertson and Leiter 2001). However, in some cases, they may well have sufficiently low magnetic field and show Type I bursts. It is now known that Cir X-1 which was considered a BHC, did show Type I burst, a signature of "hard surface". Irrespective of interpretation of presently available observations, our work has shown that the BHCs can not be, in a strict sense, (finite mass) BHs because then *timelike geodesics would become null* on their EHs.

Starting from GRB 971214 there are several powerful Gamma Ray Bursts which show no evidence for beamed emission. For GRB 971214, the total power radiated only in soft gamma rays is $Q \sim 3 \times 10^{53}$ ergs. Since the efficiency for gamma production could be considerably below 100% and since there could be substantial associated neutrino emission, the actual energy liberated in such bursts could be well above 10^{54} erg. If gravitational collapse of massive stars would have resulted in prompt formation of trapped surfaces, such huge energy emission would have been nearly impossible.

Explanation of many high energy phenomenon requires postulation of a quasi-spherical *standing shock* around the BHCs. When the BHCs have a physical surface and an intrinsic magnetic field it is easy to understand the formation of such *standing shocks*. On the other hand, it is extremely difficult to conceive of a *standing shock* supported by the EH, i.e, by *no physical surface* just like it is not possible to have a stable floor for a building which has no foundation at all. We know for certain that the astrophysical systems like

NSs and young protostars possessing physical surface, intrinsic magnetic and rotation do allow formation of “jets”. However an impression often is created in the literature that in order to explain jets from gamma sources and AGNs, it is necessary to assume the existence of BHs. The fact is that while accretion disks (physical surfaces with magnetic field) around any object might be site for a jet formation, it is not understood how jets can emanate from a BH which gulps up everything or how exactly a BH helps formation of jets. For a NS with weak magnetic field, the inner disk of the accretion disk extends upto the stellar surface in order to find a “support” from a physical surface. Similarly, for a BH, the accretion disk should tend to extend all the way upto the central singularity, if it were possible, in the absence of any physical surface even though stable keplarian circular orbit is possible only upto $R = 3R_g$. Then, can there really be reasonably stable accretion disks around BHCs if they were BHs? For BH accretion, in the absence of a physical surface it is extremely difficult to see how the accretion flow can get “rebounded” unless the jet is launched far away from the disk. All such conceptual problems are absent when we realize that BHCs are actually ECOs which in a broad sense may behave something like a magnetized NS. Then it becomes much easier to understand acceleration of charged particles by the BHCs in the AGNs. It is one of the tasks for Gamma Ray Astronomy to eventually confront such questions and unravel the scientific truth.

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