

BLACK HOLE'S ODYSSEY

By RAMESH CHANDER KAPOOR

Dawn was spreading its saffron robe over the world, when Thunderbolt Zeus called an assembly of the gods on high Olympos. He addressed them in these words :

'Listen to me, gods and goddesses all, and let me tell you what is in my mind. —
'If I see any god going to help either Trojans or Danaans on his own account, he shall get a thunderstroke and go home very uncomfortable. Or I'll catch him and throw him down into Tartaros. A black hole that! A long way down! A bottomless pit under the earth! Iron gates and brazen threshold! As far below Hades as heaven is above the earth! He shall discover how much stronger I am than all the rest of you...—'

Homer (800 B. C.) from one of whose works (*The Iliad*, Book VIII, W. H. D. Rouse's translation) these lines have been quoted, could never have imagined that 3000 years later some foolhardy earthlings would be earnestly scanning the sky to pin down objects like this Tartaros of his, a bottomless pit under the earth! Today, the mysterious black hole, considered one of the most stupendous predictions of Albert Einstein's General Theory of Relativity, has become a household name in the scientific circles; so much so that the black holes now seem as ubiquitous on this planet as they might be up in the sky: they are on T-Shirts, on buttons, on stickers, on wallposters, newspapers, books, science fiction, magazines, research journals of physics and astronomy and above all in the heads of scientists who have got this obsession to know more and more about black holes! But have they really 'seen' one in the sky?

Black holes are the end products in the evolution of stars several times more massive than our Sun formed as a consequence of the gravitational collapse of their cores. The collapse makes a large amount of the core mass get jammed in so small a volume that the towering force of its gravity arrests every thing in its immediate vicinity and will not let matter, antimatter and even light to get out. The collapsed core is thus, for all practical purposes, absolutely black. From the general relativity theory, one further learns that any probes sent down by a remote observer to trace whatever happened to the collapsing core take an infinitely long time to reach its surface once it has shrunk past a certain critical radius (as far below Hades as heaven is above the earth!). Hence the name black hole. Our Sun that weighs about two billion billion billion metric tons is not

massive enough to become a black hole. Just imagine, if it could be made one, its size would be bare 6 kilometers, about 200,000 times smaller than the present one. Phenomena in the astronomically strong gravitational field of a black hole are so bizarre that sometimes the physicists wonder if laws of physics that they learnt at school so religiously have all broken down.

Since nothing will be able to come out of such a black hole, the million-dollar question is how can one 'see' one and where? It is one of the basic characteristics of a black hole that comes to the rescue. Black holes have got a rather bad (good from astronomical point of view since no astronomer would appreciate a virgin black hole) habit, viz. of consuming everything that comes their way. This surely can make it possible for them to be detectable. How? Actually, a black hole will seldom be in a vacuum (the virgin black hole) and from its surrounding space it always tends to capture gaseous material.

As a component in a double star system for instance, a black hole can get copious amounts of gaseous matter from its companion. In its fall onto the black hole, the gaseous material loses enormous amounts of energy in the form of electromagnetic waves which can escape and be received by detectors far far away. Off and on, over the last decade, black holes, big and small, have found themselves being involved in a variety of astronomical systems like double stars and globular-shaped star clusters which have been found to be powerful sources of x-rays and even centres of galaxies. The x-ray source present in a double-star system in the constellation of Cygnus, widely known as Cyg X-1, has drawn considerable attention of astronomers all over the world for the past eight years. They hold a black hole at least five times as massive as the Sun responsible for its powerful x-ray emission. The energy lost every second will be sufficient to keep the wheels of all the automobiles on the Earth moving for a hundred billion years, doing an average of hundred kilometers every day! And imagine all this from a black hole that will be only 30 kilometers across! Compare it with the Sun which measures about 1.4 million kilometers end to end! There are some other x-ray sources too with similar indications but Cyg X-1 has been considered the best black-hole candidate.

Black holes have been suspected to form in the centres of globular-shaped clusters of stars where they keep ripping gas off the stars in their vicinity when the latter venture sufficiently close.

The gas while falling into the black hole releases vast amounts of energy as powerful radiation. A number of globular star clusters have been recently found to be powerful sources of x-rays and, according to John Bahcall and Jeremiah Ostriker (both at Princeton), these might be breeding black holes in their centres as massive as a thousand suns. Then last year, two teams of astronomers in the United States reported the results of their studies of an elliptical-shaped galaxy in the constellation of Virgo, known as M87, which suggested that a supermassive black hole with a mass as much as five billion times the Sun's (and a diameter of about 30 billion kilometers) might be lurking in its centre.

The latest on the scene now is the strange object referred to as Stephenson-Sanduleak-433 which according to Drs James Pringle and R. Terlevich of Institute of Astronomy at Cambridge (England) is a gigantic black hole, weighing as much as 300,000 times the Sun and spanning about 1.8 million kilometers across, a distance light takes about 6 seconds to cover! The black hole in SS-433 is understood to be surrounded by a ring of gaseous matter which goes in circular orbits round, falls onto it and gives off powerful radiation. In fact, it was the strange behaviour shown by the bright lines present in the spectrum of the light of SS-433 (obtained through a spectrograph attached to a large size telescope) that led these astrophysicists to the conclusion, published recently in the eminent British journal of science *Nature* (April 19, 1979), that the object is most likely a massive black hole.

According to some other astrophysicists, there could be lot of such gigantic black holes present in the Milky Way the Solar System is a part of. If such black holes are around aplenty, the nearest one is estimated to be several thousand light years from us!