Energy machines in outer space

Black holes and white holes alternately implode and explode like massive oscillators producing the energy that drives the universe.

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IT is not only the mortals on the planet Earth who are looking for sources of energy to meet their daily requirements. Energy sources are needed to power the vast astronomical objects that exist all over the universe. And not in every case does the astronomer yet know what it is that keeps these objects radiating in some cases for millions and billions of years.

Right at our doorstep we have the sun pouring out 3 billion billion billion units (kilowatt hours) of energy every year. What is the source of sun's energy ? What is the reservoir on which the Sun has been drawing for nearly five billion years and on which it is expected to draw for energy for a similar amount in the future ? Thanks to the progress of thermonuclear physics, these questions have now been answered. The Sun, like any other star, has a gigantic fusion reactor deep in its interior. By converting hydrogen nuclei into helium nuclei at a temperature exceeding ten million degrees, this process provides the requisite amount of energy to keep the Sun shining. It is the very same process that man is trying to emulate (so far unsuccessfully) to meet his energy needs for the future.

But the Sun's energy needs are miniscule compared to those of many other astronomical objects. For example, by the beginning of the 1960s the radio astronomers had discovered strong sources of radiation beyond our Galaxy, which seemed to demand energy reservoirs several billion times those of the Sun. Then in 1963 came the quasars which made matters worse for the theoretician. For, quasars appeared to be starlike objects and yet they seemed to require energies upwards of a million suns. Fred Hoyle and William Fowler were the first to point out that thermonuclear reactions would be inadequate to supply the requisite amount of energy in a quasar. Some new energy source was needed and Hoyle and Fowler suggested gravity as the key to the mystery. When a massive object, say a million to billion times the Sun, shrinks rapidly under its own gravitational pull. vast amount of energy could be released.

The humans also use gravity as a source of energy. When water comes crashing down from a height in a waterfall it acquires energy due to the Earth's gravity. By building a hydro-electric power station man has cleverly utilized this energy source. He gets electrical energy out of gravitational energy. Similarly the astronomer has to think of a clever enough scenario for converting gravitational energy into energy of cosmic radiation.

It is here that the black hole acquired such popularity in the 1970s. A black hole is an object so massive and yet so small in size that on its suface the gravitational pull is enormous, so enormous that not even light can escape from it. (The Earth would become black hole if it were to shrink to a sphere of radius less than 8 millimetres !) Astronomers suggested that black holes form in space by the shrinkage of massive conglomerations of matter. Thus black holes in masses ranging from a few times the mass of the Sun to several billion times the mass of the Sun were postulated by several theoreticians from all over the world. To name a few : Zeldovich and Sunyaev from the USSR, Marin Rees from UK, Blandford, Bahcall and Ostriker from the USA and so on. The list is a long one, and the list of black hole theories even longer.

Black holes are attractive as cosmic energy machines because by their strong pull of gravity they attract the surrounding matter which spirals inwards and ultimately falls in. The high infall speed of this matter generates the radiation which is observed. The X-ray source Cygnus X-1 which is located in a binary star system is considered a strong candidate for housing a black hole.

Attractive though the black holes are in many ways, the fact that they are not directly observable remains a drawback in their gaining more popularity. Their existence must be inferred by circumstantial evidence and only if other more conventional explanations don't work. To paraphrase Sherlock Holmes : "When you have eliminated the impossible, whatever remains,

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however improbable must be the black hole". Skeptics will continue to ask whether the observations of any cosmic source of radiation really warrants the assumption of a black hole.

By contrast, the opposites of black holes, the so called 'white holes' are readily observable. Whereas a black hole is formed by collapsing, imploding matter, the white hole describes a gigantic cosmic *explosion*. An explosion generates lot of energy, both as radiation and as fast moving particles. Many astronomical objects do show evidence of explosion. Are white holes operating in these sites ?

That white holes could be responsible for many high energy phenomena in astrophysics was suggested in 1976 by J V Narlikar and K M V Apparao at the Tata Institute of Fundamental Research, Bombay. Like black holes, the white holes can range in masses from stellar order to several billion times the mass of the Sun. Last year Fred Hoyle suggested that the universe may contain white holes of million billion solar masses which show up as large clusters of galaxies. The big bang model of the universe is the biggest white hole possible with a mass in excess of a thousand billion billion suns !

However, the white holes also have certain weaknesses. How did they start ? We do not know what could have triggered a white hole explosion. Are white holes the sites where new matter is pouring into the universe ? If so scientists will be worried at what they would regard as a blatant violation of the law of conservation of matter and energy. Further, some theorists have argued that white holes are highly unstable and cannot last long enough to be viable energy machines.

To get round these difficulties Narlikar and Apparao have recently proposed that the universe may be containing massive oscillators which combine useful features of both the black holes and white holes. As its name suggests, the massive oscillator alternately implodes and explodes, thus simulating a black hole and a white hole. To convert an implosion to explosion a strong force of repulsion is needed, a force which becomes powerful only when the objects is dense and small. In successive oscillations the gravitational energy is pumped out of the object into the surrounding medium which radiates it out. This theory, to be published in the Astrophysics and Space Sciences Journal in the UK will represent yet another attempt in the astronomer's search for an efficient and powerful cosmic energy machine .□

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