# news and views

## X-ray sources and Occam's razor

WHEN two or more theories are available to explain the same observable phenomenon, it is usually a good bet to accept the simplest theory as the basis for further investigation. This powerful rule of thumb has many applications in astronomy, and 'works', for example, if used to assess the relative merits of theories of planetary motions. Straightforward elliptical orbits are simpler and easier to work with than complex interactions of cycles and epicycles, although admittedly the second model can be made to give the right answers. So can this philosophy be applied to the question of black holes, which is currently one of the most contentious issues in astronomy? Clearly, it can; the question which must be resolved is whether it is simpler to explain observations of objects such as Cyg X-1 in terms of black holes, or by invoking more conventional astronomical phenomena.

There is no doubt that the rapidly varying X-ray sources which burst upon the astronomical scene with the advent of the Uhuru satellite must be very compact objects. The only plausible energy source for the X-ray production mechanism is the release of gravitational energy as matter accretes onto a small, dense object—that is, a white dwarf, a neutron star or a black hole. Furthermore, the lengths of the periodicities found in some of these sources suggest, from even the most naive considerations, that the X-ray flux observed is being modulated by rotation or pulsation of just such compact objects. Perhaps it is natural that theoreticians should look for explanations involving the more extreme of these alternatives, since it is only by studying events occurring in such extreme conditions that theories can be pushed beyond their present limits of known reliability; however, there has recently been a tendency for models of these X-ray sources to move back one step towards the less exotic. In the case of Her X-1 and Cen X-3, it seems that white dwarfs, rather than neutron stars, are sufficient to explain the observations; in the case of Cyg X-1, a plausible model involving a neutron star rather than a black hole is put forward on page 351 of this issue of *Nature* by Fabian, Pringle and Whelan.

As far as Cen X-3 is concerned, the first suggestion that the periodic variations found could be explained in terms of white dwarf pulsations came very soon after the discovery of these periodicities (Gribbin, *Nature, phys. Sci.*, **233,** 18–19; 1971). But although that model "has the merit of providing a ready explanation for the fluctuations in the periods . . . which could be related to changes in the property of the star caused by the impingement of . . . gas streams", in 1971 attention remained focussed on neutron star models, and few people wanted to know about mundane explanations in terms of white dwarfs. Recently, however, DeGregoria and Woltjer have taken this idea a step further (*Nature phys. Sci.*, **246,** 108–109; 1973). They have investigated both Her X-1, which has a period of roughly 1.24 s that varies in a "rather complex" way, and Cen X-3, which shows a roughly 4.8 s period. It seems that certain models of pulsating white dwarfs which failed to account for the pulsar phenomenon can explain these X-ray variables. The mass inferred for Her X-1 is 1.3 $M_\odot$, and DeGregoria and Woltjer point out that the 1.24 s period of the source corresponds to the first harmonic vibration of a pure helium white dwarf model with a mass of 1.2 $M_\odot$, according to Faulkner and Gribbin (*Nature*, **218,** 734–736; 1968); similarly, the 4.8 s variation of Cen X-3 can be explained in terms of a white dwarf of mass 0.6 $M_\odot$.

One powerful argument in favour of these models is that "no plausible evolutionary scheme exists to explain the presence of a neutron star in . . . HZ Her" but "many binaries with white dwarf companions do exist" and there is no reason why mass transfer in these systems should not lead to X-ray production. "Models involving pulsating white dwarfs should not be prematurely rejected", say DeGregoria and Woltjer.

The model for Cyg X-1 put forward by Fabian *et al.* is a little more exotic than these white dwarf models—but less exotic, perhaps, than models involving black holes. There seems little doubt that if Cyg X-1 is a binary then the X-ray emission is associated with a compact object so massive that it must be a black hole. But is Cyg X-1 a binary? About a third of observed binaries are actually triple systems, and if Cyg X-1 is one of these then the mass problem can be removed. If the secondary is itself made up of two stars, a 1 $M_\odot$ neutron star orbiting a 10 $M_\odot$ B1V star, the observed modulation of the light curve of Cyg X-1 can be explained.

The conclusion is that "as yet there is no need to invoke the existence of black holes to explain the properties of X-ray sources". That may come as a disappointment to those relativists still searching for a spectacular proof that general relativity holds even in extreme conditions; but the mere suggestion that black holes might have been discovered has produced a wealth of theoretical ideas encouraging rapid development of a better understanding of high energy astrophysical processes, acting as a catalyst in a way reminscent of how the steady state theory encouraged the development of cosmology in the 1950s and 1960s.

It may be that when the impossible has been eliminated whatever remains, however improbable, must be the truth. But alternatives to the black hole explanation of Cyg X-1 are not, it seems, impossible after all. J. G.

## Cysteines at the interface

ONE of the most intriguing aspects of haemoglobin chemistry has been waiting more than a century for an explanation in structural terms. Since its discovery by Körber in 1866, the striking resistance of human foetal oxyhaemoglobin (Hb-F) to alkaline denaturation, in comparison to the adult protein (Hb-A), has been exploited by clinical chemists for the analysis of mixtures of Hb-F and Hb-A It is practicable to work at a *p*H, around 12.6, where the times for half-denaturation differ by two orders of magnitude (about 1000 s for Hb-F compared with about 10 s for Hb-A), and much ingenuity has been shown in devising convenient routine procedures and in extending the sensitivity and reliability of the methods to low proportions of Hb-F.

It has often been suggested that this difference in stability of Hb-F and Hb-A arises from the ease by which the tetramer molecule dissociates into dimers and monomers. Since the work of Itano and colleagues in 1967 and of others, the