attenuated blood forms for which the factors determining virulence and transmissibility are only just being understood[13]. The development of *in vitro* culture techniques has made it possible to prepare a vaccine from soluble antigens released into the culture media. So far, three antigens in the molecular weight range 37–40,000 have been identified[14] and these have been used as vaccines against homologous[15,16] and heterologous[17] challenge but with no more success than with the conventional vaccine.

Although immunology dominated the meeting significant progress was reported in other areas, such as *in vitro* cultivation. Of particular interest was the successful cultivation of the liver stages of *P. vivax* in hepatocytes[18] and the reports of mass cultivation techniques for *P. falciparum*[19,20].

In epidemiology, the use of computer simulations of field situations for both malaria[21] and babesiosis[22] has reached very sophisticated levels and will improve our understanding of the complex nature of these diseases — a prerequisite for any comprehensive control strategy. However, the main weapon of control, chemotherapy, is in a very poor state. With increasing resistance to antimalarials, including Mefloquine, which has not been widely released[23], clinicians are having to rely on old remedies such as quinine. Possible new antimalarials including Halofantrine[24] and Pyridinemethanol (WR180, 409)[25] show promise as do derivatives of the Chinese folk drug artemisinine such as artesulate which is many times more effective than quinine[23]. Drug resistance has also been experienced in babesiosis[15] but there are no new drugs on the way. One wonders what the situation in chemotherapy would have been like if a fraction of the effort devoted to immunology had been diverted in its direction. One thing is certain, though, malaria and babesiosis will stilll be with us when the third conference is held. □

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Astronomy

Formation and fate of interacting binaries

from Virginia Trimble

BINARY stars as a subject of scientific inquiry are, in one sense, very old (ancient and boring, many of our colleagues in extragalactic astronomy would say), having been invented by John Michell[1] more than two hundred years ago when he pointed out that the number of close pairs of stars in the sky is so large that most of them must be physically connected and not just chance superpositions. In another sense, the subject of interacting binaries is quite young. The first international meeting devoted exclusively to them (International Astronomical Union Colloquium no. 6) took place in September 1969 in Elsinore, Denmark, and the most recent (a NATO Advanced Studies Institute) in August 1983 in Cambridge, UK. None of the official participants in the former was present at the latter, marking 14 years as the length of a generation of binary-star astronomers, at least in their guise as conference goers.

During this recent historical period, our physical understanding of interacting binaries has tended to proceed from the middle evolutionary phases outwards in both directions. The first systems to be put on a firm theoretical foundation were the Algols[2], which represent the stage when the more rapidly evolving component has nearly completed the process of transferring material to its companion. Next came the cataclysmic variables[3,4] and X-ray binaries[5,6], in which the first star has exhausted its nuclear fuel and is accreting material transferred back from the secondary. Then the phases just before and during rapid transfer, termed RS CVn[7,8] and Serpentid[9] systems, were identified; and plausible models were calculated[10] for very close pairs of main-sequence stars sharing a common envelope (W Ursa Majoris variables).

Now we are finally beginning to sneak up on the earliest and latest phases. The result is not always increased clarity. We used, for instance, to believe that the fission of a single rotating gas mass would make close pairs with nearly identical components, while separate condensation would make wide pairs with the primary much more massive than the secondary[11-13]. Some recent models work this way[14]. Others do not. Gingold and Monaghan[15] have found that fission of a differentially rotating cloud can produce close pairs with mass ratios very different from one. And P. Artymowicz (University of Warsaw) reported calculations of separate accretion (on to cores of 0.2 solar masses resulting from hierarchical fragmentation) whose most likely product is a close pair with total mass 1–3 solar masses and mass ratio near one.

At the other end of the evolutionary track, R.E. Nather (University of Texas, Austin) discussed the close pairs of white dwarfs that seem to be descendents of cataclysmic systems. There are now three (AM CVn, GP Com and PG1346+082), raising them to the status of a well known class of astronomical object. Systems like them are strong candidates for the immediate progenitors of type I supernovae[16-18]. All three were found by accident. Thus close binary white dwarfs could be very common, and one of the questions left unanswered at the end of the meeting was how to search efficiently for the ones in which the stars are not interacting.

The progenitors of cataclysmic variables are seen in rather larger numbers than the products. H. Bond (Louisiana State University) showed data for about a dozen promising systems. That is, they are close, but non-interacting, pairs with one main-sequence component and one that is either ionizing a planetary nebula or identifiable as a white dwarf or 0 subdwarf. 'Close' means both that the stars must have spiralled together since the white dwarf was a red giant and that loss of angular momentum by gravitational radiation and/or winds will cause them to interact within another Hubble time. These systems appear to be the short-period tail of a more extensive class. Bond also listed a somewhat larger number of WD+MS systems with periods greater than 1.5 days. These are unlikely to come into contact in the age of the Universe, but are too close to have evolved without extensive loss of angular momentum.

Most of the necessary angular momentum loss appears to have occurred during a phase when the stars share a common envelope[19]. R. Taam (University of Illinois) presented results of two-dimensional calculations of binary systems enveloped by the expansion of a red giant. Mass outflow occurred at rates as large as 10^{26} g s^{-1}, mostly in the equatorial plane. Complete expulsion of the envelope occurred most readily in wide systems (because the red giant was more extended and its envelope less tightly bound when the process started) and took only a few years. No wonder we don't catch many systems in the act.

We still cannot say that we understand the evolution of binary systems from symmetry breaking in the early Universe to the boiling off of black holes by Hawking radiation. But progress is being made. □

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