ASTRONOMY

One little, two little . . . binary pulsars

One of the conceptual difficulties in astrophysics is that the categories of things seldom stay simple and neatly distinguished. It used to be possible to say that radio pulsars stood alone in the sky, while X-ray pulsars were members of binary star systems. There was one exception on both sides: The Crab nebula pulsar, the only known object to pulse in both radio and X-rays (and light as well), is a single star. There was also one radio pulsar known to inhabit a binary system. Then there were two binary radio pulsars. Now there is a third.

A survey of the sky north of declination +20° has recently been completed by M. Damashek of the National Radio Astronomy Observatory and J. H. Taylor, K. R. Burkhardt and P. R. Backus of the University of Massachusetts. They report in THE ASTROPHYSICAL JOURNAL, Vol. 253, p. L57, that they detected 50 radio pulsars, of which 23 were previously unknown. One of the new ones, PSR 0655+64, is in a binary system that has an orbital period of 88,877.05 seconds (slightly less than 25 hours).

Binary radio pulsars are something of an embarrassment to theory. The usual hypothesis is that radio pulsars are neutron stars and, as such, are what remains of the cores of stars that have undergone supernova explosions. Such an explosion should blow any binary (or ternary or quaternary) companions loose, and the resulting neutron star should be left alone. One binary radio pulsar could be ingeniously explained as some kind of anomaly. Three of them go a long way to being a subclass of their own and needing a codicil to the theory to explain them.

And a pulsar in a supernova remnant

If pulsars (of any kind) are made in supernova explosions, they should appear to be associated with supernova remnants (SNRs), slowly expanding clouds of gas that such explosions also leave behind.

To the embarrassment of theorists again only two radio pulsars, the very exceptional Crab and the somewhat exceptional Vela pulsars, and one X-ray pulsar besides the Crab appeared definitely associated with SNRs. Now there is another X-ray pulsar in a SNR, reported by F. D. Seward and F. R. Harnden Jr. of the Harvard-Smithsonian Center for Astrophysics in a paper submitted to THE ASTROPHYSICAL JOURNAL.

Their discovery is a pulsing X-ray source in the SNR cataloged as MSH15-52, which is detectable by its radio emission and located in the constellation Circinus. This X-ray source is now the third known X-ray pulsar in a SNR (with the Crab and an X-ray source in the SNR G109.1-1.0) and the fourth of any kind in a SNR.

Its pulse period is very fast, 0.150 seconds. The rate of increase of period with time is the largest measured for any pulsar and suggests to the discoverers that the pulsar may be part of a binary system. Spectrographically the whole Circinus system has similarities to the Crab, and Seward and Harnden suggest a search for optical and radio pulses from it.

And another squirting star

SS433 is the catalog number of a star that exhibits several peculiar rotary motions and seems to be shooting matter into space in two revolving beams like a complicated searchlight. SS433 used to be unique among stars. (Similar behavior is seen in quasars and entire galaxies.) Now there is another, the star R Aquarii. Radio observations by Andrew Michalitsianos of the NASA Goddard Space Flight Center and optical observations by George Herbig of the Lick Observatory have found a jet of matter coming out of it. Robert Sopka of the University of Maryland has found a radio source near R Aquarii that may represent material ejected by it decades ago.

ENVIRONMENT

Erosion: How does air factor in?

Past work on erosion has suggested that the primary contributor of energy to move soil particles has been a raindrop's impact. But Albert Jarrett thinks there's more to the story. The buildup of pressure as soil-entrapped air is compacted by rain during a heavy shower is another potentially important energy source, the Pennsylvania State University agricultural engineer contends. And this could prove an initiator or promoter of erosion in certain soils.

Erosion is a two-phase process. "You've got to detach particles from the soil surface," Jarrett explains, "and then you have to transport them." He believes that if soil-entrapped air is restricted from moving downward—for instance, by the presence of rock, a water table or clay basin—its pressure will build until high enough to counter the force of the water and bubble to the surface. It's the energy dissipated as the air explodes at the soil surface, he says, that may provide much of the energy for detaching particles from the soil surface.

For air entrapment to play an active role, rainfall must be intense enough to cause surface ponding, Jarrett says. And for most soils, only a heavy thunderstorm will do that. "Over a year's time, an area like Pennsylvania is going only to get that type of rain maybe three to five times," he says. "And we know from other work done in a completely independent setting that a majority of the erosion which occurs in a year results from at most three or four storms." Is there a correlation? "I think so, but I can't prove it," Jarrett says.

In recent experiments, one of Jarrett's students ran water slowly over test beds that were three feet long, one foot wide, and canted at a two percent slope. One trapped air, another vented it freely out the bottom. And their contrast was "spectacular," Jarrett told SCIENCE NEWS. "We're talking about anywhere from 300 to 500 or 600 percent increases in erosion as a result of trapping the air."

Soil is most susceptible to air entrapment right after it has been tilled, when the air content is highest. Venting air, Jarrett suggests, will not only reduce erosion, but also increase the soil's uptake of water as much as 50 percent—reducing the need to irrigate. At issue is how to vent. A half-inch-diameter polyvinyl-chloride pipe full of holes and planted vertically works well, but sited every five to 10 feet throughout a field it could be expensive. The old farm practice of vertical mulching—filling vertical slits full of porous, organic material such as straw—may prove more cost effective.

A drug that protects against radiation

Concerned that soldiers might perish in a nuclear attack, the Army has screened thousands of drugs over the last couple of decades in search of a pill that could be administered to troops as protection against the effects of radiation. Emerging as the top contender was S-2-(3-amino-propylamino) ethyl dihydrogen phosphorothioate. Though 10 years of animal tests confirm the drug's promise, the army has had trouble maintaining its efficacy when it is packaged in pill form—a necessity for use in the front lines.

Whether or not the drug—also known as Walter Reed-2721—pans out as a battlefield shield, it may aid cancer patients undergoing radiation therapy. The reason: only normal body cells readily absorb the compound. Solid-tumor cells shun the drug and its protection against radiation. Researchers hope it may permit the use of larger radiation doses on human tumors. Under the National Cancer Institute's direction, clinical trials are now underway at six university medical centers—using intravenous solutions of the drug—to establish whether it can be tolerated comfortably in patients at doses large enough to be useful.