SCIENCE NEWS of the week

Stellar Evolution Spins a Surprise Stage

Babies grow up so fast that many a parent will say that if you turn your head, you miss a whole interesting stage of development. Stars take eons to develop, and yet now it seems that if astronomers turn their heads in the wrong direction they can miss a relevant stage in the lives of baby stars. The right direction happens to be the Pleiades, and it is observations of certain fast-rotating young stars in that cluster that now leads to the recognition of a hitherto unknown, short (by astronomical time scales) and puzzling stage of stellar evolution.

Douglas K. Duncan of Mt. Wilson and Las Campañas Observatories presented a paper on the discovery with Geoffrey W. Marcy of Mt. Wilson and Las Campañas and Ross D. Cohen of the University of California at San Diego at last week's meeting in Baltimore of the American Astronomical Society.

The story begins with some photometry of faint stars in the famous Pleiades star cluster by two astronomers associated with the European Southern Observatory. These are all very young stars, says Duncan, and the surprise was that the brightnesses of many of these stars varied by more than 10 percent at periods of less than a day.

Young stars tend to have large spots, and these variations in brightness are attributed to the passage of spots (which are darker than the rest of the surface) across our line of sight. But such fast fluctuations would mean the stars were rotating at periods of less than a day. Spectroscopic study by David Soderblom and John Stouffer of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., of the Doppler-shifted broadening of spectral lines that rotation causes confirmed the ultrafast rotation of 30 percent of the approximately 60 stars they observed in the Pleiades.

Generally it was expected that stellar rotation slows down uniformly with age. "Nobody had expected a period when stars spin up," Duncan says. This was a complete and puzzling surprise. The youngest visible stars, T Tauri stars, do not rotate as fast. The expected rotation period for stars of spectral class K (which the ultrafast stars are) at this age is about a week. The sun, a much older star, rotates once in 25 days. Now astronomers have to account for a spin up and presumably a spin down.

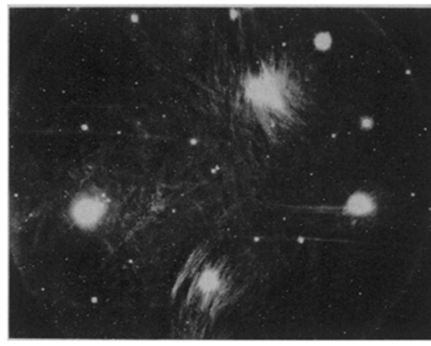
Marcy, Duncan and Cohen studied the fastest rotator among these Pleiades stars, Hz 1883. It goes around every six hours, a fast clip for a star, and it seems to be throwing off large amounts of matter. The evidence is in the changes, a cyclic shift to the red and the blue, of the spectral emission line hydrogen alpha. The shift toward the red and then back toward blue indicates that the matter emitting the hydrogen alpha light is coming off the star, not in a spherically symmetrical way, but in a bipolar way, in oppositely directed jets. Duncan says the calculated velocity is 400 kilometers per second, just about escape velocity from the star.

If the outflowing stuff actually escapes, its loss should cause the star to spin down, as it carries away angular momentum, that is, rotary motion. Calculating the loss rate, the observers come to a spin down time to reach the "normal" spin rate for stars of this age on the order of 10 million years. Knowing the age of the K stars in the Pleiades, Duncan says, they find that it fits that 70 percent of them look "normal" while 30 percent are still somewhere in this curious spin-up-spin-down stage. "We are not prepared to say what causes the spin up," Duncan says.

Stars begin as mass concentrations in interstellar gas clouds. There are many suggestions as to what triggers such concentrations, but eventually they get dense enough for nuclear burning to start, and then they become visible. Each spectral class evolves along its own path to reach the "main sequence," where it spends its mature, working life. The term main sequence comes from the Hertzsprung-Russell diagram, a way of arranging the stars graphically according to spectral class (equals surface temperature) on the horizontal axis from O through B, A, F, G and K to M and absolute magnitude on the vertical axis. The main sequence is a sigmoid band across the diagram from very bright in the hottest spectral classes (O, B, A) to quite dim for the coolest (M). The classes from O to F are generally called "early type" as they pass their main sequence period in what appears a more primitive, brighter state than the one the "late type" stars have achieved by the time they reach the main sequence.

This spin-up-spin-down stage, first seen in the K class, may be typical of late type stars generally, astronomers suspect, and the most recent research seems to support the suspicion. Duncan remarked that just that morning in the corridor Stouffer had told him of a recent look at the young star cluster alpha Persei, more distant and difficult to study, in which G stars seem to be spinning "faster than you would expect."

The sun is a G star, and if G stars generally have this stage, the sun may have experienced it billions of years ago. The violent activity involved in the spin down represents tremendous amounts of convective activity in the star. This results in a tremendous increase in radiation, ultraviolet and gamma rays, bathing any planets the star may have. Coming from the sun, this radiation could have had significant effects on the development of the earth. Among other things it might have destroyed whatever primary atmosphere the earth may have had. (Earth scientists tend to agree that the present atmosphere is a secondary development.)



Fast-living young stars are a mystery encountered in the Pleiades.

Duncan hopes that as the news of the observation percolates among theorists, they will be able to figure out what causes this new stage of stellar development and how it fits into the overall picture.

—*D. E. Thomsen*

Mass extinctions: Galactic yo-yo effect

Periodic mass extinctions of living species appear to have occurred in the history of the earth. Although there are some dissenting voices, paleontologists seem to agree that such things occur on a cycle of about 28 million years. To Luis Alvarez of the University of California at Berkeley is attributed the first suggestion that the extinctions are caused by impacts of comets on the earth. Two suggestions have recently been made as to what might cause such periodic comet hits (SN: 4/21/84, p. 250)—one involving a companion star to the sun, the other the interstellar clouds — and now Roman Smoluchowski of the University of Texas at Austin comes up with a third, galactic gravitation.

Smoluchowski, an astronomer and physicist, spoke at last week's meeting in Baltimore of the American Astronomical Society.

Astronomers generally agree that comets come from the Oort cloud, a collection of cosmic debris orbiting the sun in a spherical shell about 100,000 times as far as the earth or half the distance to the nearest star, Proxima Centauri. Occasionally something — the passage of another star or a similar gravitational disturbance —perturbs the Oort cloud, knocking some of its protocomets out of their orbits and sending them into the inner solar system, where they may be captured as periodic comets or zip around the sun and go back out. On the way, such comets might occa-