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This report covers the interval 1 July 1995 - 30 June 1996

1. PERSONNEL

Drs. G. Chanmugam, J. S. Drilling, J. Frank, A. U. Landolt, C. L. Perry, and J. E. Tohline made up the permanent teaching faculty in the Department of Physics and Astronomy's astronomy/astrophysics group. Dr. A. K. Uomoto, The Johns Hopkins University, and Landolt continued working on the latter's CCD faint standard star project. D. Christodoulou continued in his postdoctoral position in Tohline's group.

Dr. C. L. Perry retired from the Department effective 31 December 1995.

We report with sorrow that Dr. G. Chanmugan passed away on 25 March 1996.

Geoffrey C. Clayton and Geoffrey S. Burks will join the department in tenure track and instructor positions, respectively, in August, 1996.

Graduate students for the year were Saied Andalib, Kimberly Barker New, John Cazes, Howard Cohl, Sandeep Dani (Computer Science), Paul Fisher, Katrina Loewe, Patrick McCormick, Karl Misselt, Patrick Motl, Aruna Rajasekhar, and Sridharan Ramakrishnan. New received her Ph.D under Tohline's direction.

2. RESEARCH

Chanmugam with graduate students Aruna Rajasekhar and Erik Young have shown that it is not surprising that the spin-down age of the Vela pulsar differs from its true age because the magnetic fields of young pulsars are likely to vary in timescales comparable to the age of young supernova remnants (MNRAS, 276, L21, 1995).

Chanmugam and graduate student Erik Young have been studying the effects of accretion on the magnetic field of an X-ray pulsar. They have considered the thermal effects on the conduction and they have also examined the effectsof pressure and diffusion limited drag on the field, assuming the situation can be modelled with simple MHD flows with appropriate boundary conditions.

Graduate student Horst Vath with Chanmugam and Frank analyzed the optical and infrared polarization light curves of the intermediate polar RE 0751+14 obtaining a polar magnetic field of 9-21 MG for this system. Thus this system may be the prime example of asynchronous rotators which will become synchronous (polars) as they eveolve to shorter orbital periods (ApJ 457, 407, 1996).

Drilling took a Sabbatical during this reporting period at the Dr. Remeis Sternwarte in Bamberg, the Department of Physics and Astronomy at St. Andrews, and the Indian Institute of Astrophysics in Bangalore. Talks were given at these institutions and at the Hamburg, Kiel, Munich, and Potsdam Observatories. HST observations were obtained for HD 44179 and V348 Sgr, and IUE observations for K2-16. The following papers were published or completed during this reporting period: UV Spectrophotometry of the Hottest Stars in the Southern HK Survey (Drilling, J.S., and Beers, T.C. 1995, Ap.J. Letters 446, L27), An Extension of the Case-Hamburg OB-Star Survey (Drilling, J.S., and Bergeron, L.E. 1995, PASP 107, 846), Basic Data on Hydrogen-Deficient Stars (Drilling, J.S. 1996, ASP Conf. Ser. 96, 461), Spectral Analysis of the Extreme Helium Star LSS 3184 (Drilling, J.S., Jeffery, C.S., and Heber, U. 1996, ASP Conf. Ser. 96, 172), Spectral Analysis of Helium-Rich sdO Stars (Drilling, J.S., Napiwotzki, S., Dreizler, S., Heber, U., and Beers, T.C.,1996, ASP Conf. Ser. 96, 317), A Catalog of Hydrogen-Deficient Stars (Jeffery, C.S., Heber, U., Hill, P.W., Dreizler, S., Drilling, J.S, Lawson, W.A., Leuenhagen, U., and Werner, K. 1996, ASP Conf. Ser. 96, 471), The Photometric Classification of Field Horizontal Branch Stars (Philip, A.G.D., and Drilling, J.S. 1996, ASP Conf. Ser. 92), Normal Stars (Drilling, J.S., and Landolt, A.U., chapter in fourth edition of ''Astrophysical Quantities,'' in press), The Ultraviolet Extinction Curve for Circumstellar Dust formed in the Hydrogen-Poor Environment of V348 Sagittarii (Drilling, J.S., Hecht, J.H., Clayton, G.C., Mattei, J.A., Landolt, A.U., and Whitney, B.A., Ap.J., in press).

Frank (with King, Kolb and Ritter) has been investigating the stability of mass transfer from an irradiated dwarf companion in cataclysmic variables. They have completed the analysis of the variability in companion radius and the resulting mass transfer oscillations and have shown that irradiation can drive long term mass transfer cycles (ApJ 444, L40, 1995; and ApJ467, 761, 1996). Such cycles are too long to be observed directly but could explain the observed scatter in mass transfer rates at a given binary period. The analysis of the effects of irradiation on giant companions is also near completion.

Frank and graduate student Patrick McCormick have continued their studies of the orbital evolution of the progenitors of binary pulsars and have begun the modelling of radiation-driven mass transfer cycles in cataclysmic variables with dwarf companions, using the double polytrope representation for the companion.

Frank and graduate student Patrick Motl have been studying the settling of gas in AGN hosts using analytical and numerical techniques; the stability of a disk gas of arbitrary rotation embedded in a galactic potential can now be tackled using a SCF code to set up initial states.

Frank and graduate student Sridharan Ramakrishnan have been modeling the structure of two-temperature accretion columns in AM Herculis systems with the aim of introducing a simple treatment of cyclotron cooling and studying its effect on the X-ray temperature.

Landolt continued his work at telescopes at Kitt Peak, Cerro Tololo, and Las Campanas. The data being obtained will result in faint broad-band standard stars centered at the celestial equator and encircling the celestial sphere. Both

photoelectric and CCD photometric data were obtained, the latter in conjunction with A. K. Uomoto, The John Hopkins University.

Work on Landolt's UVBRI photometric standard star sequences at +45 degrees declination were slowed by the closure of the 1.3-m telescope at Kitt Peak. Data for the program were obtained at the KPNO 0.9-m telescope with the CCDPHOT technique. Initial reductions indicated a lack of accuracy in the U, and hence (U-B) results. Tests are continuing.

Timings of minima of selected eclipsing binaries were obtained by Landolt during environmental circumstances when one would not want to do standard star work. The eclipsing systems observed included CG Cyg, V704 Cyg, BC Gru, Y Hyi, and RW Phe.

Landolt obtained scattered broad-band photometry of the novae N Cas 1993, N Aql 1993, N Aql 1995, and N Cen 1995, of several hydrogen-deficient stars and of several FU Ori stars.

The heretofore photometric standard star HD 173637 (Landolt, Astron. J., 88, 439, 1983) continued in its bright state at about V = 8.88. The object apparently is a shell star.

Landolt continued to monitor the globular clusters M 80 and NGC 7492 with CCDs at Las Campanas when observing conditions prevented the acquisition of standard star quality data. These data will be used for a search for variable stars in these two globular clusters.

Under Tohline's direction, graduate student Kimberly New completed her doctoral dissertation entitled, ''Gravitational Radiation from and Instabilities in Compact Stars and Compact Binary Systems.'' Through this research project, three types of compact astrophysical systems were studied as possible sources of detectable gravitational wave radiation (GWR): nonaxisymmetric pulsars; rapidly rotating compact stars undergoing the bar-mode instability; and coalescing compact binaries. The analysis of nonaxisymmetric pulsars (Ap.J., 450, 752, 1995), performed in collaboration with Chanmugam and W. Johnson (LSU), indicates that nearby millisecond pulsars are generally better candidates for the detection of GWR than the Crab pulsar, which has been the object of some ongoing searches. New's simulation of an object encountering the rotationally induced bar-mode instability resulted in an ellipsoidal final configuration which persists for a large number of rotation periods, continuously emitting GWR. This simulation was performed with a finite-difference hydrodynamic technique and the result is inconsistent with previously published results by other groups who have employed smoothed-particle hydrodynamics. The persistence of a bar-like final configuration suggests that such an instability in rapidly rotating compact stars will produce objects that are fairly bright sources of GWR.

In their analysis of the relative stability of compact binary systems, New and Tohline examined equal mass systems with polytropic, white dwarf, and neutron star equations of state. They began the investigation by performing finite-difference, Newtonian hydrodynamic simulations of individual models constructed along equilibrium sequences of binaries with the same total mass and equation of state, but decreasing separation. Equilibrium models were introduced into the hydrodynamic code and evolved for several orbital periods in order to determine if any models on these sequences were unstable to merger on a dynamical timescale. The simulations indicate that no points of instability exist on white dwarf sequences or on polytropic sequences with polytropic indices n = 1.5 and n = 1.0. However, binary models on an n = 0.5 sequence and on sequences with realistic neutron star equations of state were found to be unstable to merger if they had sufficiently small separations. The hydrodynamic code was used to follow the evolution of a binary system with the minimum total energy and angular momentum on the n = 0.5 polytropic sequence through coalescence. At the end of the simulation, the ellipsoidal central object was encircled by spiral arms which had been ejected during the merger, and was continuously emitting low-amplitude GWR.

Graduate student Andalib, in collaboration with Tohline and senior postdoctoral research associate Christodoulou, has completed a survey of the principal modes of nonaxisymmetric instability in self-gravitating accretion-disk models. This survey, scheduled for publication in the ApJ Supplements Series in early 1997, is a comprehensive analysis of the three modes of instability for incompressible, slender, self-gravitating tori having constant specific angular momentum and orbiting a central point mass. A careful analysis has been made of the instability regimes as a function of (primarily) the mass ratio between the torus and the central star and $T/|W|$, the ratio of rotational to gravitational energy.

Andalib has also developed a new ''self-consistent-field'' technique that allows one to construct equilibrium, self-gravitating structures with compressible equations of state, nontrivial internal motions, and nontrivial surface geometries. Presently the technique is restricted to two-dimensional structures, but it offers the promise that realistic, steady-state structures with ellipsoidal (or more complicated) shapes can be constructed and their relative stability examined. Such a tool will be useful in studies of rapidly rotating protostars, galaxy disks, and compact objects that are likely to be sources of continuous wave gravitational radiation.

Working with Tohline and graduate student Cazes, Christodoulou has investigated numerically the stability and temporal evolution of two-dimensional self-gravitating galaxy rings with flat rotation curves. Massless and very low-mass rings have been found to be unconditionally stable against self-gravity driven modes and convective modes. As the ring mass is increased, relative to the interior mass of the dark halo, one of three unstable modes appear. Strong unstable modes commonly are found to cause a temporal breakup of the ring and the formation of a new, lumpy but long-lived ring structure. One conclusion drawn from this study is that neither nuclear rings in barred galaxies or in active galactic nuclei, nor counter-rotating cores or polar rings in elliptical/S0 galaxies can safely accumulate matter through accretion and survive in a smooth form.

Working with Tohline, graduate student Fisher has been examining the dy namical settling of gaseous disks in normal

galaxies in an effort to understand the time-evolution of systems that show sizeable warped disk structures, and graduate student Cohl has been developing numerical tools that will permit the careful examination of fragmentation processes during supersonic cloud collisions in an effort to understand the formation of star clusters.

3. MISCELLANEOUS

Landolt continued as Secretary of the American Astronomical Society, and in a term on the Board of Governors of the American Institute of Physics. He continued to participate in the AAS Shapley Visiting Professor Program.

Arlo U. Landolt