COMMISSION 35: STELLAR CONSTITUTION (CONSTITUTION DES ETOILES)

Report of Meetings 20 November 1985

PRESIDENT: A. N. Cox VICE PRESIDENT: D. Sugimoto

20 November 1985

I. BUSINESS MEETING

The business meeting was started by a moment of silence with the members standing in respect for three members that had passed away since the last meeting in 1982. These names were read by the President: John P. Cox, Sven Rosseland, and Stefan Temesvary.

New officers were voted for in an election held between March and June 1985, and the results were reported by the President in a letter dated June 30 to all the members of the Commission. The President, Vice President and the Organizing Committee members were endorsed by the Executive Committee at the General Assembly after the Commission 35 business meeting. The new President is Daiichiro Sugimoto (Japan), who was elected Vice President before the Patras 1982 General Assembly and was expected to succeed to be President in 1985. The election for recommendations to the Executive Committee resulted in Andre Maeder (Switzerland) as the new Vice President.

The election by the rules agreed upon at the Montreal General Assembly resulted in a tie for second place among four candidates for the Organizing Committee. It was decided by the President to offer all five new names, and this was accepted at the business meeting. The current Organizing Committee then consists of the five carryover people and the five new ones: P. Bodenheimer (USA), C. Chiosi (Italy) A. N. Cox (USA), D. O. Gough (UK), R. Kippenhahn (FRG), Y. Osaki (Japan), J.-L. Tassoul (Canada), J. W. Truran (USA), V. Weidemann (FRG), and J. C. Wheeler (USA). The incoming President asked A. Tutukov to be a special consultant to him and the Organizing Committee to secure close contact with the USSR and its neighborhood.

Due to the new computer now in the Secretariat in Paris, it has been possible to computerize the lists of members of the IAU and the various Commissions. Letters were sent to all IAU members by the Secretariat to see if they still want to remain members and to secure current addresses, etc. Numerous changes in Commission memberships resulted, and the actual Commission 35 membership is still being sorted out by the new President at the time of this report after the General Assembly. There are new members who have been IAU members for some time, and there are new members who have been just elected to the IAU. There are also resignations from some who have been listed by mistake. Professor Ludwig Biermann has asked to be deleted from membership of Commission 35 so that he can pursue other interests in other Commissions. The total membership now is approximately 291.

The President brought to the Commission a proposal to form a Working Group on Theoretical Solar Models and Solar Oscillations. The problem is that the several groups calculating solar models and their predicted oscillation frequencies differ more among themselves than do the many observations. The causes of these differences can be many, and they need to be discovered and

eliminated to take advantage of the very accurate observed frequencies. Professors Christensen-Dalsgaard and Ulrich are already working with the several theoretical groups on this problem, and it was decided by the Commission that formation of a Working Group was not necessary from any point of view. The Working Group will not be formed, but the activity of the solar oscillation predictors was strongly endorsed.

Three proposed IAU sponsored meetings were discussed by the Commission. Endorsement by many of the Organizing Committee members had already been secured at the time of the business meeting. A Symposium on planetary Nebulae to be held in Mexico in October 1987 was made by J. B. Kaler (USA). Another Symposium on Atmospheric Phenomena as Manifestation of Internal Evolution of Stars was proposed for Tokyo in August 1987 by K. Nomoto (Japan). This now has been changed to be a Colloquium. A Colloquium on Faint Blue Stars to be held in Tucson in the Spring of 1987 was proposed by A. G. D. Philip (USA). All these conferences were enthusiastically supported by the Commission with some possible better definition for the Atmospheric Phenomena proposal. The Executive Committee has accepted the first and last of these three conferences at the time of this report.

Da Run Xiong from Nanjing, China gave a brief report on the work being done in his country, because the research from this newly adhering country is not so well known to the members. He also discussed briefly his work on nonlocal convection theory.

The usual triennial report of Commission 35 was published along with the other Commission reports in volume 19a Reports on Astronomy in mid-1985. Scientific reports were Massive Stars (R. M. Humphreys), Rotation in Late Type Stars (W. Benz), Helioseismology (Christiansen-Dalsgaard), Planetary Nebula Central Stars (E. M. Sion), Pulsations in Hot Degenerate Dwarf Stars (A. N. Cox and S. D. Kawaler), and White Dwarfs (V. Weidemann).

II. SCIENTIFIC MEETINGS

There were five scientific meetings of Commission 35, two concerned with our main business of stellar structure and evolution, two as a Joint Commission meeting with Commissions 25, 37, and 45 on Precision Photometry of Clusters, and a brainstorming session mostly with Commission 27 and 35 members on the theoretical problems in the B star pulsations. Only the first two of these sessions are reported here. The Joint Commission meeting will be reported as a Commission 37 meeting, and the brainstorming session was organized informally by M. Aizenman with no program or conclusions.

Commission 35 also jointly sponsored three Joint Discussions: Solar and Stellar Nonradial Oscillations, Stellar Activity: Rotation and Magnetic Fields, and Supernovae. Proceedings of these three will be found in Highlights of Astronomy.

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Stellar Surface Abundances

A. Tutukov	Introduction
A. Maeder	Chemistry of Massive Stars
D. Schoenberner	OBN Stars
D. Lambert	Chemistry of AGB Stars
R. Kraft	Carbon and Nitrogen Abundances in the Atmospheres of Giants and Subgiants of Metal Poor Galactic Clusters
G. Michaud	Abundance Anomalies and Stellar Hydrodynamics
K. Hunger	On the IAU Colloquium 87 "Hydrogen Deficient Stars and Related Objects"

In a brief introduction, Tutukov pointed out that 97 per cent of the stars display abundances that are normal while only 3 per cent are peculiar. Three processes contribute to the peculiar abundances - mass loss, internal mixing in the star, and accretion. In the first case, the mass loss can be because of a binary companion or because of a stellar wind. The mixing in stars has many causes, among them being convection, semi-convection, circulation, diffusion, and shear flows. Accretion can occur from a close binary or from interstellar matter.

Maeder discussed the mass loss, convective dredgeup, overshooting, and turbulent diffusion as causes for the abundance peculiarities seen in massive stars. Nitrogen 14, a common isotope in normal stellar material is enhanced in hydrogen burning by the CNO cycle and then later is converted to Neon 22 in the helium burning stages in the core of massive stars. Two alpha particle captures make this element disappear as evolution proceeds. When this processed material reaches the surface, continuously for the large mass loss and deep dredgeup case for 100 solar mass, the C/N ratio drops at first from its normal value of 4.1 to 0.02 and then increases to over 1000 as the nitrogen disappears. The same drop and rise is also seen for the O/N ratio. The various Wolf-Rayet stages are then: WNL-hydrogen and nitrogen seen, WNE-hydrogen exhausted but nitrogen not yet depleted, WC-all H and N gone but considerable C from helium burning, WO-both C and O present as a result of the very hot helium burning in layers now exposed by mixing and dredgeup.

Schoenberner presented some observational data for 4 OBN stars (HD 89137, HD 14633 θ Car, and HD 48279) and 3 ones (τ Sco 10 Lac, and 15 Mon) with normal compositions. Non-LTE atmospheres were constructed to analyze the CNO abundances. Incomplete CN cycle H burning is verified for masses in the range of 20 to 30 solar mass. Overshooting of the convection and large mass loss are both needed to explain large He overabundances in the surface exposed material. Mixing and processing of envelope matter occurs right at the early main sequence stages.

Lambert discussed the AGB stars with their preflash helium shell flash compositions and their compositions after the s-processing flashes. Spectral classes M, MS, and S were studied using synthetic spectra. Data on the s-process abundances correlate with the carbon abundance as expected. Ratios of the carbon 12 to carbon 13 and carbon 12 to oxygen 16 were also presented.

The old population CNO abundance question was discussed by Kraft, who has measured these abundances in metal poor galactic clusters. The giants and subgiants, which have dredged up some processed material, show the expected decrease in carbon and increase in nitrogen. For a given C/Fe ratio, however, the clusters show more nitrogen enhancement than field stars. The issue of whether this difference could be due to a primordial variation as seen in metal poor globular clusters like M92 and M15 was discussed. The actual rate of nitrogen enhancement and carbon depletion among the subgiants was presented.

Michaud discussed the lithium abundance question for the dwarf stars. The relative importance of lithium settling and dredge up of the lithium is important in this case. As evolution brings these stars to cooler surface effective temperatures, the convection zone depth increases rapidly. Then the lithium that has settled away is retrieved to bring the surface abundance back to the value for the hotter stars. This happens because the settling time grows longer for the cooler temperatures, and the lithium cannot get away. It is also important to consider at the same time the helium settling, because the depth of the convection zone depends on the helium abundance. Mass loss rates cannot be larger than about 10^{-15} solar mass per year, or the settling velocity will be reversed by the mass loss flow.

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Finally, Hunger gave a very brief report on the IAU Colloquium held just before the General Assembly in Mysore. He presented the whole array of hydrogen deficient star types and concluded that most, if not all, were the result of normal stellar evolution.

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General Scientific Session

D. Sugimoto	Eddington Luminosity of X-Ray Bursts and the Distance to the Galactic Center
T. Lee	The Astrophysical Source of the Extinct Ration-Nuclides in the Early Solar System, New Clues from Recent Cr Data
C.-K. Chou	Angular Momentum Transport in a Protostar Disk System
C. Mohan and M. Saxena	Effects of Rotation and Tidal Distortion on the Periods of Small Adiabatic Radial and Nonradial Modes of Oscillations of Stellar Models
H. A. Hill	The Sun's Gravitational Quadrupole Moment Inferred From the Fine Structure of the Acoustic and Gravity Normal Spectra of the Sun
C. A. Rouse	Periods of g-Modes in Solar Models with a High Z Iron-like Core

The aim of this paper is to draw the attention to the possible importance of x-ray bursts as a standard candle to determine for instance distances to the galactic center.

Recently, the structure of x-ray bursting neutron stars has been studied by solving the stellar structure with a steadily mass-losing envelope. The theory is being elaborated by T. Ebisuzaki and K. Nomoto taking into account the transport on non-equilibrium radiation through the extended envelope of the neutron star. Since the time scale of the x-ray bursts is much shorter than the dynamical time scale of the neutron star, the luminosity cannot exceed the Eddington limit by more than several percent.

There are also, from the study of the observations during the burst, good physical reasons to assume that the strongest burst of an individual source is equal to the Eddington luminosity. Therefore, the distance can be determined. With the distances obtained for different x-ray bursts, their spatial distribution was plotted and the center of their distribution was found to be situated at the distance of 7 kpc in the direction of the galactic center.

The author emphasizes the astrophysical information provided by the study of isotopic ratios in rocks and meteorites and discusses the interest of chromium isotopes. The chromium isotopic anomalies of $^{53}Cr/^{52}/Cr$ and $^{54}/Cr/^{52}/Cr$ in Allende refractory inclusions have been analyzed; the author discusses the results of Birck and Allègre, who found isotopic anomalies in the range of 5×10^{-4}, with an excess of ^{54}Cr and a deficiency in ^{53}Cr. The author examines the various astrophysical sites where the above enhancements can be produced and concludes that reactions associated with ^{28}Si-burning in supernovae of Type II could explain the above anomalies.

The author uses properties of the model of density waves in the framework of the models of collapsing clouds with an emphasis on the transport of angular momentum in rotating protostellar disks. The application of stability criteria to such disks leads to the results that the growth of the stellar angular momentum in the protostar is limited by the transfer in the disk. The author considers that the effect of the viscous damping is likely to cause the excess of

angular momentum to be deposited within a small region close to the protostar.

The authors present the explicit mathematical formulations of the eigenvalue problems of radial and nonradial modes of oscillations of stellar models incorporating the effects of both rotation as well as tidal distortion forces. The mathematical formulations of these eigenvalue problems have been developed making use of the averaging technique of Kippenhahn and Thomas (1970), "Stellar Rotation," ed. A. Stettbak, p. 20) for incorporating the effects of rotation and tidal distortions on the equilibrium structure of a star in conjunction with Kopal's method (1972. Adv. Astron. Astrophys. Vol. 9, p. 1) for evaluating various equilibrium structure parameters on the Roche equipotential surfaces. The effectiveness of the approach developed is illustrated by the authors, who apply their method to 10, 5, and 2 M_θ main-sequence models.

The fine structure of 30 low-order, low-degree acoustic mode multiplets, the average fine structure of $\ell = 1$ and 2 intermediate-order acoustic model multiplets, and 31 low-degree gravity mode multiplets have been analyzed to infer the internal rotation of the Sun and to place upper limits on the internal magnetic fields. The multiplet classifications are based on differential velocity observations of Kotov et al. and differential radius observations. No evidence at the 7 standard deviation level was obtained to support the Duvall and Harvey findings. However, this test did yield evidence of intermediate degree f-modes with a multiplet fine structure consistent with that found in the results of previous works by H. A. Hill; this represents the first observational evidence of those f-modes located just above the asymptotic g-mode limit. The inferred angular velocity distribution based explicitly on the properties of the 63 multiplets is quite similar to the results of Hill, Rabaey and Rosenwald and yields a gravitational quadrupole moment J_2 of $= 7.7\times10^{-6}$, which has important implications for planetary tests of theories of gravitation.

The variable period spacings of the $\ell = 1,2,3$, and 4 degree g-mode of oscillation for the high Z core (HZC) solar model are discussed and found to be consistent with the high μ-gradient and central density of the HZC model. The properties of the HZC model were compared with the observed frequencies of oscillation in the five minute band and agreements were found by the author. The effect of point spacing on the predicted frequencies is also emphasized, and it is shown that it is necessary to calculate the solar model and the oscillation frequency eigenvalues with space steps smaller than 10^{-3} to as small as 10^{-5}. From his results, the author suggests that the high Z core model is favored.

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