a non-active region, the emerging flux regions occur in a random way at the rate of nearly one per day. In active regions the rate is much more, particularly during the early life of the spots. The flux regions come up in a random way in non-active regions, but appear on the site of old active regions. The form the new spot will take also depends on the remnant field in that region. This was illustrated by the fine movies Zirin showed, which included a movie on the development of a flare.

Dale Vrabec reviewed in detail the recent observations showing the migration of magnetic flux elements designated as moving magnetic features (MMF) in the vicinity of sunspots. When a spot has attained its maximum development, the magnetic fields adjacent to the outer periphery of the penumbra become fragmented and disperse over an annular region (named as the "moat" in the literature) with an extent of about 20,000 km from the outer edge of the penumbra. Time-lapse movies show that the fragments of fields in the "moat" radially move away from the sunspot. Vrabec termed these MMF as the "magnetic flux outflow" (MFO). The magnetic fields are "frozen" in the photospheric material and the MMF can be taken to map the streamlines of this velocity field. Harvey and Harvey from a study of the out flowing MMF suggest that the presence of a "moat" is a necessary condition for the occurrence of MMF. These MMF have velocities in the range of a tenth of a km to about 2 km sec^{-1}. Near the outer boundary of the moat, this movement becomes ill-defined abruptly.

MMF have a wide range of sizes, the most common being about 1500 km. Field measurement of individual MMF by Harvey and Harvey show a longitudinal field of 300 gauss. The main distinguishing character of the MMF from the non-spot magnetic field lies in their structural differences. The non-spot magnetic fields clump together to form aggregate blobs of different sizes. Similar blobs form the network. The MMF occuring in the moats tend to occur as single entities, representing the most elementary forms of the magnetic fields found on the solar surface. Another interesting aspect of the review was the discussion of the observations made at Kitt Peak which showed that the MFO is the agency responsible for the steady transfer of magnetic fields from a decaying spot, into the surrounding net work. Observations on two spots showed that the rate of transfer of the flux by the MFO was equal to the rate of decrease of flux in the spot. Similarly there are preliminary observations showing the existense of magnetic flux inflow, transferring magnetic elements into the umbra of a large spot during the early stages of its rapid growth.

One of the features on the solar surface that interested solar observers was the "filigree" described by Beckers. The bright features seen in the filtergrams obtained in the wings of H-alpha (at 2Å off band) constitute the filigree. These features are 4 sec of arc in size. They form a net work of the dimensions 1200 to 2700 km across. They occur on the boundaries of the granules, i.e. on the dark lanes of the granules. In quiet regions, changes in the geometry take place in 5-10 mins. How is the filigree related to the magnetic field and how does their brightness structure in other lines differ from that in H-alpha are questions awaiting answers.

By far the most important features in the upper chromosphere are the spicules. Although a lot of information has piled about their profiles, their dynamics, etc., some of the more fundamental problems, like their identity with disc features—dark and bright mottles —and the role they play in transporting energy to the corona remain still unanswered.

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Report on the I.A.U. Symposium No. 60

on "Galactic Radio Astronomy"

The symposium on Galactic Radio Astronomy was held at Maroochydore, north of Brisbane in Queensland between September 3-7, 1973. There were about 100 participants and the meetings were held in an isolated hotel on the Suncoast of Queensland.

The scientific programmes were organized in the form of 6 sessions covering the following topics : Interstellar Medium; 2) Galactic H II Regions; 3) Stellar and Circumstellar Sources; 4) Galactic Centre; 5) Large Scale Galactic Structure; and 6) Supernova Remnants. In each session, there were a number of invited papers, followed by a few contributed papers.

In the session on interstellar medium, Radhakrishnan summarised the evidence for an intercloud medium. He pointed out that there is accumulating evidence for two component structure of the interstellar medium consisting of cold dense concentrations with spin temperatures of tens of degrees embedded in a hot tenuous medium at several hundred degrees or more. Heiles presented the extremely interesting maps of the large scale distribution of neutral hydrogen obtained directly from the observed profiles without imposing a kinematic model of the galaxy. He emphasized that the maps do not substantiate many aspects of the theoretical interstellar cloud models. The maps reveal large coherent gas structures which are often filamentary in shape and aligned parallel to the interstellar magnetic field as determined from polarization of starlight. Even in small velocity ranges the maps show small scale filamentary structure with Doppler velocity gradients along their lengths. Güelin summarised the information on the density of free electrons outside H II regions, obtained from the study of emission of Hα, N II, radio recombination lines and from the dispersion measures of pulsars. He felt that the last method gave the most consistent values of about 0.03 electron per cm^{-3} for distances not too far from the Sun. Jenkins reviewed the new information on interstellar absorption lines in the ultraviolet obtained using the spectrographs on the Copernicus satellite. The number of atoms and ions which may be studied has increased from six in the visible to more than thirty. He pointed out that observations of the

H_2 molecule seemed to indicate that H_2 molecules occur either in high density small clouds or a very low density medium. He reported the detection of atomic deuterium in the direction of β Centauri with a ratio of D/H= $(1.4 \pm 0.4) \times 10^{-5}$. According to him, after correcting for depletion in stars, the above abundance implies a cosmic density of 4×10^{-31} gm cm^{-3} and a $q_o = -0.5$. There were also reviews of the processes of heating and ionization of the interstellar medium by M. Grewing, of theories of interstellar molecule formation by R. D. Brown, the local magnetic field by J. B. Whiteoak and the chemical composition and distribution of dust by J. M. Greenberg.

Radio observations of H II regions were reviewed by E. B. Churchwell during the session on H II regions. According to him the measured He to H ratios range between 6 per cent and 10 per cent in the spirals arms of our galaxy and <1 per cent in the nucleus. There was considerable discussion about the reality and significance of the result. The review of the optical observations of H II regions by G. Monnet showed the importance of optical studies, using newer instrumental techniques such as Fabry-Perot interferometers and image tubes, for information on fine structure of H II regions and on faint H II regions. The recent exciting results from infrared observations were reviewed by C. G. Wynn-Williams. From this review and the review by Burke of the maser sources in H II regions, it was clear that when OH and H_2O sources are found in H II regions, a compact source of both radio continuum and infrared emission is usually (perhaps always) found nearby. Even hough the details of the physical processes leading to tamplification are still not clear, both OH and H_2O maser sources exhibit the same appearance as a cluster of very compact sources of line radiation with the same range of radial velocities. The importance of the radial velocity structure in deriving the properties of the source clusters was emphasized in a paper by T. K. Menon. Interferometric studies of OH sources were reported by R. D. Davies who proposed a model of the OH emission regions as part of a rotating and expanding neutral shell surrounding massive central stars. He also suggested that some of the velocity structure of OH sources may be due to Zeeman splitting in a weak magnetic field. Theoretical studies of dense neutral condensations as well as those related to the OH and H_2O masers were reviewed by F. D. Kahn. He suggested the latter class of objects may be related to the shells formed around newly formed early type stars which have recently ceased accreting matter from interstellar space.

The session on stellar and circumstellar sources began with a review by L.L.E. Braes of radio observations of stellar sources. The objects detected so far include four red dwarf flare stars, three novae, two red supergiants, eight binary systems and thirteen related objects. The flare stars are known to have non-thermal spectra. For most of the others, wherever spectral data exist, the mechanism of radiation is likely to be thermal with suggested temperatures in some cases as high as 10^8°K. Models of X-ray binaries were discussed by H.D. Tananbaum. The radio and infrared properties of OH/IR and H_2O/IR sources were summarised by J.L. Caswell and A.R. Hyland respectively. It has been found that anomalous OH and H_2O microwave emission is a common occurrence in circumstellar shells surrounding cool oxygen rich M supergiants and Mira variables. Combined studies of the variability of OH and H_2O emission and the infra-red continuum of the Mira variables confirm that radiative infrared pumping is probably the dominant mechanism. Several interesting correlations have been established between the infrared colour, period and amplitude of variability, and the velocity separation of the OH emission peaks. The possibility of detecting OH emission from distant supergiants was pointed out by F. J. Kerr.

The highlight of the session on large scale galactic structure was the emphasis by several speakers on new methods of analysing 21-cm line data with a view to the study of spiral structure and other features. It had been the practice in earlier analyses to start with the assumption of circular motions and a rotational model. Burton, Weaver, Heiles and others pointed out the importance of peculiar motions both in the radial and tangential directions which have to be taken into account in deriving a convincing picture of spiral structure. The new methods of presenting the 21-cm data developed by the Berkely group brought out clearly the filamentary structure of the local hydrogen suggesting that magnetic fields most probably have important role in determining cloud structures. One of the most exciting results was that reported by D. S. Mathewson showing a low intensity high velocity stream of neutral hydrogen enveloping the Magellanic clouds and probably connected to the Galaxy. There was considerable interest in the relationship of this stream to the high velocity clouds seen elsewhere at high latitudes. G. Westerhout announced that the new Maryland-Green Bank 21-cm survey, using the improved surface of the NRAO 300 ft telescope, is complete and is available in the form of data tapes.

The complexity of the phenomena taking place in the central regions of the Galaxy were brought out in a number of review papers on the infrared, radio continuum, 21-cm line and molecular emission from these regions. Inspite of the wealth of new information no coherent picture of the physical processes taking place at the centre has as yet emerged. An alternative to the usual assumption of recent violent activity at the centre was presented by S.C. Simonson who suggested that many of the observations can be readily interpreted by a dispersion-ring model in which the observed non-circular motions originate in a resonance with a spiral wave, whose existence is inferred from other evidence. In the ensuing discussion it was apparent that we have to wait for new observations and new theoretical developments to further our understanding of the phenomena taking place at the center of our Galaxy.

The last session of the symposium was devoted to the topic of supernova remnants (SNR). It was opened with a review by B.Y. Mills. The identification of the supernova remnants in the Magellanic clouds had led to a new determination of the surface brightness-Diameter relation, thus providing a more reliable distance scale for galactic SNR. The total number of known remnants in the galaxy is about 150. The galactic SNR are distributed rather like the radio disc emission. Several polarization studies of SNR were reported by D. K. Milne, J. R. Dickel, M. R. Kundu and T. Veluswamy. The derived magnetic field patterns do not appear to show any characteristic pattern or relation to the total-power structure of the source.

Our Australian hosts deserve great credit for the efficient arrangements and providing the congenial environment for a most pleasant and valuable symposium.

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PARIS SYMPOSIUM ON GRAVITATIONAL WAVES

A colloquium entitled "Ondes Et Radiations Gravitationnales" was organised by the Centre National de la Recherche Scientifique and the Paris University at the Institut Henrie Poincare, Paris between June 18-22, 1973. About a hundred scientists working both on theoretical as well as experimental aspects in various countries participated in the symposium.

As the title of the symposium suggests, the main interest was centred round recent experiments on detection of gravitational waves. In addition to the first wave-detector constructed by Weber at Maryland and Chicago in the U.S.A., several new aluminium cylinder wave-detectors have been installed at various laboratories in Europe. Report on the wave-detection experiment in the U.S.S.R. could not be presented as scientists from the U.S.S.R. could not attend.

Last year Kafka had reported that with the Munich detector he had not recorded any coincidences and so Weber's findings did not get support from the experiments. At this symposium, Weber developed certain criteria for interpreting the results of his experiments. Kafka also devoted his lecture to analysing Weber's criteria and tried to show that whatever way one looks at his observations one cannot escape the conclusion that there are no coincidences to mark the oscillations induced by Gravitational Waves. A very lively discussion followed the two talks, which was continued at coffee-breaks and during round table meetings ("Table Ronde") in the afternoons. Ultimately it was felt that Professor Weber should visit Munich and see whether the experiment there essentially repeats his Maryland experiment and settle the issue jointly at Munich. Reports of progress in the wave-detector experiments at Frascati (Italy) and Meudon (France) were also presented at the symposium. Participants visited the Meudon observatory near Paris to see the gravitational wave-detector.

On theoretical side, Taub described his "two-timing" method of Variation for Gravitational Waves. The work has now appeared in print (Taub and MacCallum: Comm. Math. Phys. **30**, 153, 1973). R. Davis discussed issues in gravitational wave detection in space missions. In his opinion, we must improve our radar range measurements by a factor of at least 10^{-6} in order to measure the effects of a gravitational wave passing between us and a satellite. C. Misner talked about gravitational radiation emitted when a particle of small mass m is scattered by a black hole ($m << b/y$ where y is the Lorentz factor and b is the scattering width). Professor Lichnerowiez gave a talk on gravitational shock waves in which he effectively used his hydrodynamical methods to treat gravitational shocks.

There were some talks on Astrophysics, Cosmology and General Relativity. Trautman described what he calls Einstein-Cartan theory of gravitation, which is essentially a theory of gravitation with spin. He described, in brief, the theory in the form in which he had presented it in G.R.G. Journal (**3**, 167, 1972). He also derived the modified Friedman equation for a universe filled with "spinning" dust (Nature Phys. Sci., **242**, 7, 1973), and showed that his universe will not contract to a point singularity. Sciama gave a very interesting talk on Mach's principle. He started with a rough statement of Mach's principle that in some sense the metric is to be determined entirely by the energy tensor and not partly by that tensor and partly by predetermined geometry. And then he gradually developed the principle as he sees it. He concluded that metrics satisfying $R_{ik}=0$ are not consistent with Mach's principle, but the Robertson-Walker metric is. He therefore appealed to the participants to rush out of the hall and tear off all posters which indicated the way to the symposium with the help of the equation $R_{ik}=0$. Professor Banazzola, one of the organizers of the symposium got up to counsel patience because one of these posters also showed the equation $R_{ik} - \frac{1}{2} g_{ik} R = ?$ anticipating Professor Sciama's wrath ! !

Deser tried to look at the problem of quantization of the gravitational field from a novel angle. In his talk entitled, "General Relativity as a Consequence of Quantum Mechanics" he took Weinberg's work done years ago as a starting point. He described the quantum theory of a particle (as distinct from the quantum field theory) of spin 2, mass 0 and introduced assumptions which would lead to its interpretation as General Relativity, taking care that the resulting theory continues to remain self-consistent.

Everyday in the afternoons, there were round table discussions. Topics for Table Ronde were : Non-orthodox theories ; gravitational field in a continuous medium ; quantization ; wave-detetection, cosmology and astrophysics. At these meetings, small communications of fifteen minute duration were read and discussed.

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