dwarf stage. Stars in advanced stages of evolution such as giant or super giant stage are unlikely to exhibit observed phenomena associated with nonradial oscillations. In such stars nonradial oscillations if excited will be short lived. These will either get damped out or will lead to the explosions of the star itself.

In this context it may be mentioned that Chandrasekhar and Lebovitz (*Ap.J.*,**136**, 1105, 1962) had considered the possibility of explaining the variability of Beta Canis Majoris type stars on the basis of resonance between the radial and nonradial modes of oscillations. Theoretical investigation of this possibility had also lead them to conclude that if the variability of Beta Canis Majoris type stars is to be explained on the basis of resonance between the radial and nonradial modes of oscillations, then these stars must be having low central condensations and be the young stars in early stages of evolution.

The recent observations of the Sun by Severny, Kotor and Tsap (*Nature*, **259**, 87, 1976) and Brooks, Isaak and Van der Raay (*Nature*, **259**, 92, 1976) have also some relevance in the present context. The observations of these two independent groups of observers have lead astronomers to conclude that perhaps Sun is performing global oscillations with a mean period of $2^h\ 40^m$. Michalitsanos (*Bull. Astron. Soc. India*, **4**, 14, 1976) has discussed the implications of these global oscillations. If it is assumed that these oscillations are radial, then theoretical considerations lead one to a spherically homogeneous model of the Sun. But if it is assumed that Sun is a homogenous sphere, then the temperatures and pressures near the centre of the Sun cannot be so high that the nuclear reactions of the pp chain may be taking place. It will then require some fundamental changes in the present day concepts of the theory of stellar structure to account for the huge amounts of energy being released by the Sun. The other alternative to account for the observed global oscillations of the Sun as suggested by Dalsgaard and Gough (*Nature*, **259**, 87, 1976) is that these oscillations might correspond to nonradial pulsations of the solar sphere. Such nonradial pulsations are consistent with a nuclear burning pp chain core and are thus not at variance with current theories of stellar structure. The second alternative if confirmed by subsequent investigations will lend further support to the idea that young stars in early stages of evolution are more suited to exhibit phenomena associated with nonradial oscillations as we know that Sun is still a young main sequence star.

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REPORT ON A SYMPOSIUM ON INFRARED AND SUBMILLIMETRE ASTRONOMY

This symposium was jointly sponsored by COSPAR/IAU/URSI and was held at University of Pennsylvania, Philadelphia between June 8-10, 1976. It was attended by more than 75 delegates representing all parts of the world and was mainly devoted to presentation of observational data in the field of Infrared Astronomy obtained using telescopes both ground based as well as those flown on aeroplanes, balloons, rockets and satellites. The major part of the symposium time had been allotted for presentation of invited papers. As part of the symposium a panel discussion on the Infrared Astronomy Satellite (IRAS), to be launched in 1981 had been arranged under the Chairmanship of G. Neugebauer.

F. Low reviewed the performance of infrared telescope systems carried aloft in aircraft, on balloons, and sounding rockets and pointed out that they fall far short of the performance to be expected from instruments now being developed for satellite and space shuttle programs. He classified the infrared objects so far observed using a wide range of techniques into 8 categories viz: stars, planetary nebulae, H II regions, molecular clouds, diffuse emission, galactic nucleus, galactic nuclei and QSO's. The brightness of these objects was reported to range from 0.04 Jy to 10^6 Jy.

S.D. Price presented information on survey carried out for IR sources at 4 μm, 11 μm and 19 μm using a cryogenically cooled telescope flown on rockets launched from Woomera in Australia. The number of unassociated sources detected increases with wavelength and was attributed to the interaction of cosmic rays in the detector material. S.G. Kleinmann reported ground based searches at 4 μm and 11 μm using narrow beams and raster scanning to obtain more accurate position of objects in AFCRL catalogue, using an instrumental sensitivity capable of detecting objects 1 magnitude fainter than those listed in the AFCRL catalogue. The main findings of this survey are : 1) sources are concentrated in the galactic plane and are brighter than a 100 ⊙'s, if assumed to be in the spiral arms, 2) spectra of the 67 stars studied indicate continuum radiation on which absorption and emission features are superposed including silicate features, 3) about half the AFCRL sources are red giants, 4) many AFCRL sources exhibit CO features, 5) discovery of 8 new water masers all of which are variable.

A summary of ground searches of sources in AFCRL catalogue are as follows :

	4 μm sources	11 μm sources
New*	799	657
Confirmed	3	87
Not confirmed	27	281

*Sources not listed in the AFCRL catalogue.

N. Panagia reviewed available data on H II regions. The shape of the IR spectrum is in general similar for all H II regions and that the isophotes at radio wavelengths and Infrared wavelengths for quite a few objects (for W3 at 6 cm, 20 μm and 2.2 μm, for W 31 at 1.95 cm and 40-350 μm) are essentially the same leading to the conclusion that the dust is intimately mixed with gas. The spectrum is in general broader than for a single temperature nebula implying more than a single temperature for the emitting region. He presented data to show (i)that half of the Lyman continuum is absorbed by dust inside H II region and that (ii) Lyman-α radiation is not the dominant source for heating the dust. He indicated that the ratio He^{+}/H^{+} decreases as the infrared excess increases. He tried to account for the observed IR spectrum on the basis of a 4 component dust model, the dominant component being frozen molecules of size 0.1 μm and the rest due to graphite, silicates and ice.

P. J. Lena presented far-infrared observations of the Sun carried out using a balloon borne telescope and a lamellar grating interferometer. He pointed out that the Sun is essentially a uniform disc from a few μm to 1000 μm and that absorption of radiation is mostly due to H^- ion in the free-free region. The radiation from the Sun at 600 μm is polarized and has a value of 12%.

Rieke from University of Arizona discussed infrared observations of the outer solar system objects under the categories (1) nature of comets, (2) structure of planets, (3) small objects in the outer solar system and (4) constitution of bodies in the outer solar system. He pointed out that the silicate peak at 10 μm was observed in all the spectra taken of the comets at various distances from the Sun, although large fluctuations were present in its intensity. Even the 20 μm silicate feature was seen in some of the spectra and that these silicate features disappeared for comet to Sun distances greater than 2A.U. He pointed out that the nucleus of comet West was split into 4 parts and that large fluctuations in the intensity of its silicate feature was observed. 5 μm spectra of Jupiter obtained from the Kuiper airborne observatory reveal deep absorption lines due to water vapour. In the case of Saturn the brightness temperature inversion occurs over the south polar cap. A tremendously strong temperature inversion was seen in the case of Neptune and the brightness of the planet has gone up by a factor of 2-3 in the last few years.

Becklin reported infrared observations of the galactic centre obtained with a resolution of 1 arcmin. A peak is seen in the emission of the galactic centre at 50 μm and 100 μm, at the same position as that at 2.2 μm implying that the stars seen at 2.2 μm are also the source of luminosity at 50 μm and 100 μm.

He presented the following data on mass and luminosity of the galactic nucleus deduced from 2.2 μm radiation data.

Region	Luminosity	Mass
1 pc	$10^6 L_\odot$	$3 \times 10^6 M_\odot$
60 pc	$2 \times 10^8 L_\odot$	$5 \times 10^8 M_\odot$

The features of Sag A and Sag B_2 in luminosity and brightness are very similar even when viewed with a narrow beam and appear very similar at IR wavelengths. In terms of dust density Sag A and Sag B_2 are totally dissimilar. In the case of Sag B_2 the IR emission appears to arise from an optically thick dust heated by young and forming stars. The spectrum of Sag B_2 peaks at 100 μm whereas that of Sag A at 30 μm.

Harper outlined the features of the Kuiper Laboratory airborne 91 cm telescope. The sky noise was reported to be an extremely variable phenomena. He presented the following data on zenith water vapour content.

Altitude	Mid-latitude	Hawaii
12.4 km	6.0 μm	9.0 μm
13.6 km	2.5 μm	3.0 μm

C-141 has so far been used to carry observations of

(i) external galaxies

(ii) H II regions in the Far-Infrared

(iii) water vapour in Jupiter.

Hoffmann traced the growth of IR astronomical observations from balloon platforms since its beginnings in the early 1960's. The observations carried out relate to (i) surveys, (ii) mapping of sources, (iii) photometry and spectra, (iv) cosmic B. G. flux and spectra, (v) diffuse low surface brightness mapping and (vi) solar system measurements. He presented the salient features of the telescope systems operated by Goddard Space Flight Centre, University College of London, Smithsonian Astrophysics Laboratory, University of Groningen and the low background set up of the University of Arizona.

Neugebauer reported the facilities available for IR astronomy work on the 2.4 m Large Space Telescope (LST). It will be a warm telescope having a focal plane diameter or 24 arcmin. The stability of the system will be 6/1000 arcsec for observations lasting over 10 hours. Focal plane image chopper will be used for chopping the IR radiation. Photoconductive detectors and bolometers will be used for detecting infrared radiation at short and long wavelengths respectively. Apertures differing in diameter in steps of $\sqrt{2}$ will be used to define beam size. The detectors will be cooled to 2°K. About 60 mesh filters of bandwidth 10% and transmission 70% will be used to define various wavelength bands. Initially photometric observations will be attempted; later spectroscopic observations using a spectrometer of resolution $\sim 10^4$ will be undertaken.

There was a general discussion on the status of the proposed IRAS satellite to be launched in 1981. It will be a cooled telescope of angular resolution$\sim$30 arcsec. The entire operation is to be jointly financed by Netherlands, U. K. and U.S.A. 60% of the time of the satellite will be devoted to a pure survey mode and the remaining 40% of time will be devoted to relooking of a few selected objects.

S. Hayakawa discussed diffuse IR background measurements carried out using a 10 cm liquid N_2 cooled telescope with $3^\circ \times 3^\circ$ FWHM beam size at 2.4 μm ($\frac{\Delta\lambda}{\lambda}$ = 0.1 μm). He presented data which gave some evidence of spiral arms. The flux at the galactic equator was reported to be 6×10^{-10} W cm^{-2} μm^{-1} at $l^{II} = 23^\circ$ and to decrease rather steeply 8×10^{-11} W cm^{-2} μm^{-1} at $l^{II} = 75^\circ$. Stecker presented theoretical calculations on the IR background flux and predicted that I_{IR} as a function of galactic longitude will have a maximum at $l^{II} = 30^\circ$ and very low flux for $l^{II} < 50^\circ$. Wright compared the 10μm map of M17 with its radio map and showed that the compact source seen at 10μm is not present at radio wavelengths. He gave a value of 627 Jy for the integrated intensity of M17. P. Harvey presented 53 μm maps of Sag B_2 and W49 and observed that very good positional correlation exists between H II region and IR emission in the case of W49.

S. P. Maran reported results obtained by monitoring the 2.7 μm radiation emitted by a selection of late type variable stars by the U. S. Air Force satellite instrumentation during the last three years. A well defined linear increase in flux density (in the light curve) is found to characterize the first three tenths of each cycle following infrared minimum of a long period variable star. It was pointed out that the observed infrared variability was much less than the visual variability. M. W. Werner reported observations of H II region molecular cloud complexes from the NASA C141 Kuiper Airborne observatory using a detector system which observes the same one arcmin field of view simultaneously in three wavelength bands centered at 30, 50 and 100 μm. Sources NGC7539, DR21 and Sgr B_2 have been mapped over regions of 5 to 10 arcmin in size with one arcmin resolution in all the 3 bands. Large variations in the 50μm to 100μm flux ratio was seen for each source implying significant dust temperature variations over the source. Baluteau described the features of a Michelson interferometer of high resolution ($\lambda/\Delta\lambda \sim 10^4$) which was used on NASA C-141 telescope to observe infrared emission lines from H II regions. The instrument operates in the rapid mode under computer control and high resolution scanning spectra are computed, averaged and displayed on-line. The emission line from S III at 18.7μm has been detected in the orion nebula. The spectral resolution was 0.03 cm^{-1}. Duthie described the special features of a lamellar grating interferometer used on the C-141 telescope. The system was sensitive from 50μm to beyond 600μm with a maximum resolving power of 500 at 100μm. Raw spectrum of Mars, Jupiter and Saturn at 3.2 cm^{-1} resolution and of KL Nebula at 13.1 cm^{-1} resolution (with 15 μm of precipitable water above the telescope) were presented. Telluric lines from Jupiter have been observed. L. J. Caroff presented low resolution spectra of SgrA and SgrB_2 in the region 45-250 μm using a single beam Michelson interferometer with the telescope on the NASA Kuiper Airborne observatory. Fits to the spectrum of SgrB_2 using optical depth and temperature as parameters lead to a to a temperature of 30-35° for Sgr B_2.

D. E. Kleinmann presented infrared data on the extragalactic sources M82, NGC1068 and NGC253 obtained from balloon-borne and air-borne observations. M82 and NGC1068 both have an unusually broad spectrum.

Presented below is a summary of their luminosities.

Galaxy	Dist (Mpc)	$\frac{L_{10\mu m}}{L_\odot}$	$\frac{L_{Total}}{L_\odot}$	$\frac{L_{Total}}{L_{10\mu m}}$
NGC 1068	20	4.4×10^{10}	3.7×10^{11}	84
M82	3.2	1.9×10^{9}	3.0×10^{10}	15.5
NGC 257	3.1	4.3×10^{8}	2.1×10^{10}	50

F. Low described the features of the single mirror off-axis 20 cm aperture telescope developed for observations in the 50-300 μm band. The mirror is gold coated to reduce the emissivity of the telescope. It has a 3 axis pointing system. A star sensor allows visual observation of stars. Positioning is better than 0.1 degree in both altitude and azimuth. The beam size is 15 arcmin and the peak-to-peak noise equivalent flux with one second integration time is$\sim$1000 Jy. The weight of the telescope is about 100 kgm. Sky noise is observed only at angles within 10° of horizon and at sun rise and twilight hours.

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ANNOUNCEMENT

A Winter School in Plasma Astrophysics is to be held at Ooty in March 1977. For details contact Dr. T. Velusamy, Radio Astronomy Centre, Post Box 8, Ootacamund 543 001, Tamil Nadu.