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[S0002-7537(93)00431-7]

This report covers the period from January 1 to December 31, 1999.

The Instituto de Astronomía (UNAM) has a total number of 70 full time researchers and 57 technical staff members in its three locations: Mexico City, Ensenada (Baja California) and Morelia (Michoacán). The institute also operates the OAN (Observatorio Astronómico Nacional) in the San Pedro Mártir mountains in Baja California. In August 1st (1999), Professor Paris Pishmish passed away; the institute lost one of its most distinguished members, a lucid scientist and generous teacher, and a beloved friend.

1 STAFF

Director: S. Torres-Peimbert
 Director of the OAN: M. Tapia
 Scientific staff : L. Aguilar, C. Allen, M. Alvarez, S. Ambrocio, A. Arellano Ferro, S.J. Arthur, R. Avila-Reese, V. Avila, E. Benítez, L. Binette, J. Bohigas, J. Cantó, L. Carigi, L. Carrasco, R. Carrillo, H. Castañeda, P. Colín, C. Colomé, R. Costero, I. Cruz-González, S. Curiel, P. D'Alessio, J. de Diego, D. Dultzin-Hacyan, J. Echevarría, V. Escalante, J. Espresate, J. Fierro, C. Firmani, J. Franco, J. Galindo, J. A. García-Barreto, G. García-Segura, A. Gazol, L. Georgiev, Y. Gómez, J. González, Q. Gu, W. Henney, H. Hernández Toledo, M. Herrera, D. Hiriart, G. Koenigsberger, S. Kurtz, W. Lee, S. Lizano, J.A. López, E. Luna, M. Martos, R. Michel, M.A. Moreno Corral, E. Moreno, V.G. Orlov, D. Page, A. Peimbert, M. Peimbert, R. Peniche, M. Peña, J.H. Peña, H. Plana, A. Poveda, A. Raga, M. Reyes-Ruiz, M.G. Richer, M. Rosado, R. Ruelas-Mayorga, E. Ruíz, L. Sánchez, W.J. Schuster, A. Serrano, M. Tapia, S. Torres-Peimbert, G. Tovmassian, R. Vázquez, E. Vázquez-Semadeni, H. Velázquez, V.V. Voitsekhovich, A. Watson

2 OBSERVATORIO ASTRONÓMICO NACIONAL

2.1 Facilities

The OAN is maintained and operated by the Instituto de Astronomía. The observatory has 3 telescopes, of 2.1, 1.5, and 0.8 meter diameters. A number of instruments (including CCD imagers, spectrographs, scanning Fabry-Perot interferometer, IR camera + spectrograph + Fabry-Perot, photometers, etc.) are available at the 2.1m and 1.5m telescopes. Several projects for new instruments are in progress.

2.2 The Telescopio Infrarrojo Mexicano (TIM)

The TIM infrared/optical telescope is in the planning stage. The TIM will have a 6.5 meter (effective diameter), segmented mirror, and a set of instruments spanning the 0.3 to 20 micron wavelength range. Progress has been made on the design of the telescope itself, and of the dome.

2.3 Other instrumental development

A new, actively supported secondary has been installed in the 1.5m telescope.

An infrared, 32 actuator adaptive optics system is being developed. This camera will be used in the 2.1m telescope at the OAN.

A low resolution spectrograph for the 2-20 micron wavelength range is being built.

3 PARTICIPATION IN OTHER OBSERVATORIES

The optics for a low resolution spectrograph for the HET (the new segmented mirror telescope at MacDonald Observatory, Texas) have been designed and built. This collaboration with MacDonald has been done in exchange for observing time at the HET.

A participation in the GTC segmented mirror telescope (of 10m effective diameter, which is being built in the Canary Islands, Spain) is being planned. In particular, the Institute is participating in the design and construction of the multi-object spectrograph "OSIRIS."

4 RADIO ASTRONOMY

Researchers from the institute have been involved in the development and early use of the new 7 mm detectors for the VLA (which were partly funded from a grant from the Mexican research council). Very recently, the funding for a Mexican participation in the ALMA interferometer (in Chile) has been approved. A group of researchers from our institute (led by L.F. Rodríguez) in this way has secured continued access to top ranking radio interferometric facilities.

5 COMPUTING FACILITIES

The institute has many workstations which have been bought with both UNAM and research grant funds, as well as a large number of PC's. There are also three recently installed PC clusters (one in each branch of the institute), and an Origin 2000 parallel computer (in Ensenada). Researchers from the institute have access to the vector and parallel supercomputers of the computer center of the UNAM.

6 CONFERENCES

The "Astrophysical Plasmas" conference took place in Mexico City in October 1999. This conference covered a range of topics related to fully and partially ionized plasmas, and was organized with the participation of a group of researchers from our institute (Arthur, Binette, Franco, Martos).

The proceedings of the "Interstellar Turbulence" conference (which took place in Puebla in February 1998) were published, edited by Franco and Carramiñana (from the IN-AOE, Puebla).

7 INTERSTELLAR MEDIUM

7.1 Planetary Nebulae

Several photometric and spectroscopic studies of WR stars and their surrounding nebulae have been carried out (Arrieta, Rosado). Recent detections of recombination line emission at radio wavelengths have permitted interesting studies of multipolar protoplanetary nebulae (Gómez, López, Rodríguez, in collaboration with R. Vázquez from the IAA, Granada). A number of point-symmetric PNe have been studied with optical spectroscopy and imaging, as well as some nebulae with high velocity outflows (López). Detailed optical and IR observations of other PNe and of extended gas around luminous blue variables have also been carried out (López). HST observations of the “etched hourglass” nebula (MyCn 18) have been obtained (Watson). A study of hydrodynamical and MHD models of bipolar PN models has been made (Franco, García-Segura).

7.2 H II regions

A high resolution, IR Fabry-Perot study of the “fingers” emerging from the BN-KL region has been carried out, showing the detailed kinematic structure of this very complex region (Bernal, Cruz-González, Gutiérrez, Lazo, Luna, Rosado, Ruíz, Salas, Valdéz). Observations of the partially ionized zone of M 42 have been carried out (Peimbert, Torres-Peimbert). An analysis of spectra of the “proplyds” in M 42 has been done with the Keck telescope (Henney). A radio continuum study of resolved ultracompact H II regions has been carried out (Kurtz, Watson).

7.3 Herbig-Haro objects

Fabry-Perot observations of HH 311, HH 399, and other Herbig-Haro objects have been carried out (Arias, Raga, Rosado, Watson). Double radio continuum and IR jets have been discovered (Rodríguez), showing evidence for outflows from young binaries. A study of the radio sources in the HH 7-11 region has been made (Curiel, Rodríguez). The effect of an external photoionizing field as well as the preionization due to shocks in multidimensional models of HH objects has been studied for the first time (Arthur, Binette, Cantó, López-Martín, Raga). The first predictions of emission line ratios from turbulent mixing layer models has been carried out (Binette, Cantó, Raga).

7.4 SN Remnants

Wide field, scanning Fabry-Perot studies of the Cygnus Loop have been carried out (Bohigas). A detailed theoretical study of outbursts from luminous blue variables has been made for the development of the Homunculus in Eta Carinae (García-Segura). Multifluid models of dense clumps interacting with SNR's have been computed (Raga).

7.5 Molecular clouds and star formation

VLA observations of hot cores have been carried out, and the mechanisms for massive star formation have been investigated (Kurtz, Lizano, Osorio, Rodríguez). Theoretical stud-

ies of the equilibria and dynamics of clouds and hot cores have been carried out (D'Alessio, Lizano, Osorio).

Disks and molecular outflows have been imaged interferometrically (Cantó, Rodríguez). Masers associated with disks and/or outflows have permitted studies with unprecedentedly high angular resolution of this type of system (Rodríguez). High density molecular gas around outflow sources has been mapped interferometrically (Curiel, Rodríguez), and an impressively large, 1000 AU disk around a massive young star has been discovered (Kurtz).

An extensive study of the observational implications of the development of turbulence in molecular clouds has been made, and the timescales for stellar formation have been estimated (Ballesteros, Vázquez-Semadeni). The effects of supernovae and large scale stratifications on the turbulent ISM have been studied, and the general characteristics of non-linear Alfvén waves in MHD, compressible flows have been described (Gazol). The effect of spiral density waves on star formation at high galactic latitudes has been explored (Allen, Franco, Kurtz, Martos).

7.6 Accretion disks and stellar winds

An extensive study of the properties of accretion disks around T Tauri stars has been continued, and has been extended to include time-dependent effects, as well as the effect of dust (Cantó, D'Alessio, Lizano). HST observations of such objects have also been carried out (Watson). The observational properties of MHD disk-wind models have been explored (Raga). The large-scale magnetic fields generated by the α - ω dynamo mechanism in accretion disks has been explored (Reyes). Also, a theoretical study of accretion disks in PNe has been made (López, Reyes).

Interacting winds in binaries have been resolved spatially with VLA observations, allowing interesting comparisons with models of this kind of flow (Contreras, Rodríguez).

7.7 Microquasars

A detailed study of the relativistic jet from the galactic source GRS 1915+105 has been carried out (Rodríguez, in collaboration with Mirabel from Saclay, France). The recent discovery of this so-called “micro-quasar” is one of the more exciting developments in the field of astrophysical jets.

7.8 ISM in galaxies

The H I distribution in other galaxies has been studied observationally (Franco, García-Barreto). Detailed MHD models of the impact of high velocity clouds on the galactic disk have been developed (Franco, Martos, Santillán). Theoretical models of superbubble evolution (including star formation) have been applied to the LMC (Franco).

8 STELLAR AND PLANETARY ASTRONOMY

8.1 WR stars, T Tauri stars and binaries

Time-variabilities in WR systems have been interpreted in terms of different type of interactions between binary systems (Georgiev, Koenigsberger). In particular, a new model for the tidal deformations of a star due to its companion has

been explored (Moreno, Koenigsberger). Also, the variabilities of double as well as apparently single WR stars have been studied (Georgiev, Koenigsberger). Speckle observations of multiple stars have been carried out (Ávila). A detailed photometric and spectroscopic study of T Tauri stars is progressing, and has discovered periodic changes in the veiling of some T Tauri stars (Carrasco, Costero, Cruz-González).

8.2 Planetary dynamics

The effect of collisions in planetary rings has been studied (Espreate). The diameter distribution of earth-crossing asteroids has been derived (Herrera, Poveda).

8.3 Variable stars

The physical parameters of a number of δ Scuti stars have been determined (González, Peniche, Peña). A study of four W UMa eclipsing variables was concluded (Peña). A photometric study of the γ Doradus variable HR 8799 has been carried out (Arellano Ferro). The study of the X-ray emission of variable stars (as well as of other ROSAT sources) has continued (Chavarría). A kinematic study of dwarf novae has been carried out (Costero, Echevarría, Pineda). A search for luminous variable stars has been made for the M 33 galaxy (Georgiev).

8.4 Compact objects

A detailed theoretical study of coalescence in binaries involving compact objects has been carried out (Lee). The effects of submergence and re-diffusion of the magnetic field in neutron stars (following the supernova explosion) has been studied (Page).

9 GALACTIC AND EXTRAGALACTIC ASTRONOMY

9.1 Chemical composition and evolution

Continuing analyses of ground-based and HST spectra of galactic and extragalactic H II regions show evidence of abundance gradients, which are then compared with detailed models of the chemical evolution of galactic disks (Carigi, Luridiana, Peimbert, Torres-Peimbert). Line ratios from planetary nebulae have been used to determine the oxygen abundances of M 31 and M 32 (Richer). The effect of the presence of dark matter on the chemical evolution of galaxies has also been explored (Carigi, Colín, Peimbert).

9.2 Structure of galaxies

A statistical analysis of the optical emission of galaxy pairs has been made (González, Hernández, Dultzin, Toledo). A study of the young stellar content of IC 1613 has been carried out (Georgiev, Koenigsberger, Rosado). The ionized ISM of NGC 3938 has been studied with Fabry-Perot interferometry (Castañeda). The central regions of barred spirals have been studied spectroscopically (Carrillo, Franco, García-Barreto). A calibration of the 4000 Å break has been made in order to incorporate this diagnostic in stellar popu-

lation models (González). The mass of our galaxy has been estimated from a photometric survey of high-velocity stars (Moreno, Parrao, Schuster). HST observations of clusters in low luminosity spirals have been obtained (Watson).

9.3 Galactic dynamics

A new method for identifying moving groups of stars has been developed, and applied to the Hipparcos measurements of the Hyades (Aguilar). A study of wide binaries in the galactic halo was carried out (Allen, Herrera, Poveda). A catalog of apsidal periods (and other orbital elements) of 128 binaries has been compiled (Orlov). The impact of sinking satellites on galactic disks has been studied (Velázquez). Models of star formation in expanding shells have been used to interpret Gould's Belt (Franco, Moreno).

9.4 Active galaxies

A multifrequency study of the BL Lacertae object AO 0235+164 has been carried out, and the variabilities of 3C 66A and OJ 287 have been studied (Benítez, de Diego, Dultzin-Hacyan). Studies of the kinematics of high redshift active galaxies have been carried out (Binette). An extensive multifrequency catalog of LINERs has been published (Carrillo, Dultzin-Hacyan). A narrow band imaging study of weak radio galaxies has been carried out (Carrillo, Cruz-González).

An extensive search for microvariability in Seyfert I galaxies has been carried out (Cruz-González, Salas). A detailed spectroscopic and imaging study of UGC 3995 (a pair of galaxies involving a Seyfert nucleus) has been carried out, and the statistics of Seyfert companions has been studied using the Digitized Sky Survey (Dultzin-Hacyan, Krongold).

10 COSMOLOGY

The outer density profiles of dark matter haloes have been studied with N-body simulations and with a "semi-numerical" approach (Ávila-Reese, Firmani). The evolution of the bias has been studied for different cosmological models (Colín) using N-body simulations. The effect of lensing on QSO's has been studied (Orlov). A study of the hydrostatic structures resulting from the collapse of cosmological perturbations has been made (Raga).

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