

COMMISSION No. 28

GALAXIES (GALAXIES)

Report of meetings, 3, 5, 6, 8 and 9 August 1988

PRESIDENT: P.C. van der Kruit

SECRETARY: G.A. Tammann

Commission 28 was involved in three all-day Joint Discussions, of which the proceedings will be published in *Highlights of Astronomy*, Volume 8:

JD III: **Supernova 1987A in the Large Magellanic Cloud** (Commissions 27, 28, 34, 35, 40, 44, 47, 48), 4 August,

JD VI: **Disks and Jets on Various Scales in the Universe** (Commissions 28, 34, 40, 47, 48), 9 August,

JD VII: **The Hubble Space Telescope – Status and Perspectives** (Commissions 9, 28, 44, 47), 10 August.

Furthermore, Commission 28 was involved in one full-day and two half-day Joint Commission Meetings, of which the proceedings will also be published in *Highlights of Astronomy* or in the sections of other Commissions:

JCM 4: **Molecules in External Galaxies** (Commissions 28, 34, 40), 5 August,

JCM 6: **Stellar Photometry with Modern Array Detectors** (Commissions 9, 25, 26, 28, 37), 8 August,

JCM 7: **Star Clusters in the Magellanic Clouds** (Commissions 28, 35, 37), 9 August.

Two further sessions were held jointly with one other Commission: **Dark Matter in our and Nearby Galaxies** (with Commission 33) and **Galaxy Redshift Determinations: Better Techniques, Better Standards** (with Commission 30). One business session and one scientific session on “New Results” were held, while the four Working Groups each organized a half-day session. Programs of sessions and, where available, short abstracts of the papers presented follow.

3 August: Business

CHAIR: P.C. van der Kruit

The following items were covered in the business session:

**Draft report.** The commission adopted the report and endorsed the current procedure that the President includes a copy in a circular to all Commission members soon after the report's completion.

**Officers.** The Commission unanimously elected G.A. Tammann (Switzerland) as President for the following three years and E.Ye. Khachikian (USSR) as Vice-president. Outgoing members of the Organizing Committee are S. d'Odorico (Italy), J. Einasto (USSR), I.D. Karachentsev (USSR), D. Lynden-Bell (UK), V.C. Rubin (USA), A. Toomre (USA) and K.-I. Wakamatsu (Japan) and these were thanked for their contributions. Continuing members are J. Lequeux (France), Li Qi-Bin (China), H. Quintana (Chili) and P.C. van der Kruit (Netherlands). The Commission elected as new members F. Bertola (Italy), R. Ellis (UK), K.C. Freeman (Australia), J.S. Gallagher (USA), S. Okamura (Japan) and V. Trimble (USA).

As a result of a review of the membership of the Commission by the President nine members voluntarily resigned. Sixty-nine members had not replied on three occasions to circulars and reply sheets by the President and were not proposed by other members for continuation of their membership; these persons were consequently voted to be removed from the membership list. The President will inform them of this by letter.

A list of 87 proposed new members was approved by the Commission.

**Working Groups.** The Working Groups on “Magellanic Clouds”, “Galaxy Photometry and Spectrophotometry”, “Internal Motions in Galaxies” and “Supernovae” were continued.

The Working Groups were asked to arrange their chairs during their sessions.

As proposed by F. Bertola, it was decided that the Working Group on “Space Schmidt Surveys” would

be transferred to Commission 44 and H.C. Arp was elected as chairman. In case Commission 44 would not accept the Working Group (as later turned out to be the case), it would continue to reside under Commission 28.

A new Working Group on "Redshifts of Galaxies" was established and J. Huchra was elected the first chairman.

The Working Group on "Nomenclature" was re-established with K.S. de Boer as chairman.

**Other business.** The Commission was informed of those past, future and proposed IAU Symposia and Colloquia, for which Commission 28 acted or will act as sponsoring or co-sponsoring Commission.

The Vice-president thanked the President for his work in the last three years.

### 3 August: Dark Matter in Our and Nearby Galaxies

CHAIR: L. Blitz

The proceedings if this joint session are contained in the report of Commission 33.

### 5 August: Molecules in external Galaxies

CHAIR: F. Combes

The proceedings of this Joint Commission Meeting are contained in "Highlights of Astronomy".

### 5 August: Working Group on Magellanic Clouds

CHAIR: M.W. Feast

The following Organizing Committee was elected: Suntzeff (USA), Wood (Australia), de Boer (FRG), Walborn (USA), Feast (South-Africa; chairman).

The proposal for a symposium on the Magellanic Clouds in Australia in 1990 was supported. It was agreed that the Working Group would attempt to co-ordinate observational work on SN1987A.

The following papers were read:

E. Hardy (Canada): **Velocity Field of the SMC (C stars)**

J. Lequeux (France): (1) **Structure of the SMC**

(2) **Emission-line and C Stars in the SMC**

T. Lloyd Evans (South-Africa): **C Stars in the Clouds**

I.S. Glass (South-Africa): **IR Observations of Cloud Miras**

S.M. Hughes (Australia): **Long-period Variables in the LMC**

D.J. Helfand and Q. Wang (USA): (1) **Hot ISM of the LMC**

(2) **Associations, Bubbles and Superbubbles in LMC**

J.V. Feitzinger (FRG): **Turbulence in the LMC**

M.-C. Lortet (France): **Current Star Formation in the Clouds**

J.C. Blades (USA): **ISM towards SN1987A**

K.S. de Boer (FRG): **ISM near SN1987A**

P. Shull (USA): **Interaction of SNe in the LMC with the ISM**

R. Wielebinski (FRG): **Radio Continuum of the Clouds**

K.S. de Boer (FRG): **Plan for a Durchmusterung of the Clouds**

Informal discussion on the last paper continued outside the meeting.

5 August: Working Group on Internal Motions in Galaxies

CHAIR: C.J. Peterson

The following papers were presented:

**E. Athanassoula (France): Gas Flows in Barred Galaxies**

I study the flow of gas and the major families of periodic orbits in and around the bars or ovals of model barred galaxies. I show that the loci of the shocks (or density enhancements) depend on a number of parameters characterising the bar and disk potentials. Thus a comparison to the dust lanes observed in real galaxies gives indications on the underlying potentials and corresponding stellar density distributions. In particular the existence of an inner Lindblad resonance is absolutely necessary for the formation of shocks at the regions where the dust lanes along the bars are observed. The extent of the  $x_2$  and  $x_3$  families as well as the location of the ultra harmonic resonance greatly influence the existence and shape of the shocks.

**D. Bettoni and G. Galletta (Italy): Kinematics and Photometry of SB0 Galaxies**

The preliminary results of a long term project on kinematics and photometry of SB0 galaxies are presented. The more interesting findings are:

- a) In two galaxies, the edge-on system NGC 4546 and the face-on system NGC 2717, the gas and stars rotate with similar but opposite streams.
- b) A typical "double wave pattern" of the bar rotation curve has been revealed in the galaxies with intermediate inclination.
- c) Stellar and gas streamings perpendicular to the galaxy plane were probably detected in 6 almost face-on galaxies.
- d) The observed irregularities in the gas distribution, as well as the presence of retrograde motions in two systems, should be indications of an external origin of most of the gas in SB0 galaxies.

**S. Jörsäter, P.O. Lindblad (Sweden) and G.A. van Moorsel (FRG): Gas and Dust in the Barred Galaxy NGC 1365**

In this presentation we will present results obtained from CCD photometry, optical spectra and HI observations of the barred galaxy NGC 1365. We will discuss the near-nuclear properties of the velocity field and its relation to gas and dust distribution as well as star formation. We will also discuss the properties of the global velocity field.

**C.J. Peterson and M.A. Harper (USA): Kinematics of the Ionized Gas in M83**

The velocity field of the barred galaxy M83 = NGC 5236 [type SAB(s)c] has been mapped by use of the emission lines of H $\alpha$ , N[II], and S[I] on long-slit image-tube spectrograms from the CTIO 4m telescope. Our global velocity pattern is in good agreement with the Fabry-Perot velocity field obtained by de Vaucouleurs, Pence, and Davoust (1983, Ap. J. Suppl. 53, 17), although small systematic differences do exist between the two studies and produce a rotation curve here that is 15 percent higher. The long-slit velocities further reveal significant small scale structure in the velocity field and a complex pattern of motion in the nuclear region.

**R. Buta (USA): Kinematics and Dynamics of Inner Rings in Spiral Galaxies**

The inner rings found in early- to intermediate type barred and weakly barred spirals are usually regions where H- $\alpha$  emission is concentrated within a narrow range of radii. Often, there is little emission from inside or outside the ring, thereby making the global kinematics difficult to assess. The concentration of emission within the rings affords us the opportunity to explore ring kinematics in detail, however, and can provide useful information needed for comparisons with theoretical models of ringed galaxies.

The four spirals, NGC 1512, 3351, 4725, and 4736, are excellent, nearby examples of ringed galaxies whose kinematic properties have been studied using H- $\alpha$  Fabry-Perot interferometry. The results show that the kinematic line of nodes for circular rotation does not agree with the position angle of the major axis of the inner ring for any of these objects, suggesting either that the rings are intrinsically elliptical in shape, or that expanding/contracting motions are prevalent. Only for the NGC 4725 does the velocity-position

angle diagram of the inner ring show an unmistakable asymmetry indicative of significant non-circular motions. A possible interpretation is that this ring is expanding at 52 km/sec and rotating at 219 km/sec. However, for all four galaxies, models of stable elliptical orbits provide fits to the kinematics of the rings which are just as acceptable as pure rotation or expanding/contracting ring fits. In no case is a unique kinematic model of the ring achievable, owing to inadequate knowledge of the parent galaxy orientation parameters.

**B. Jarvis (Switzerland): Kinematical Evidence for a Central Mass Concentration in the Sombrero Galaxy (NGC 4594)**

We present new medium resolution kinematic data for the major axis of the Sombrero galaxy (NGC 4594). These data reveal a sharp mean increase of about  $59 \text{ km s}^{-1}$  in the velocity dispersion within  $4.2''$  of the center. The velocity gradient across the nucleus within this same distance is measured at  $38 \text{ km s}^{-1} \text{ arcsec}^{-1}$ , insufficient to produce the observed peak in velocity dispersion by rotational broadening alone. We conclude that there is strong evidence that NGC 4594 contains a supermassive object, possibly a black hole or massive star cluster. In the simplest case of spherical symmetry we estimate a total mass  $M = 1.3 \times 10^9 M_{\odot}$  inside a region of radius  $r = 3.5''$  ( $= 309 \text{ pc}$ ,  $D = 18.2 \text{ Mpc}$ ) of the center of the galaxy.

**P.T. de Zeeuw (USA), L.S. Sparke (Netherlands), E.M. Sadler (Australia), J. Danziger (FRG), D. Bettoni and F. Bertola (Italy): Kinematics of Gas in NGC 5077**

$H\alpha$  images of the E3 galaxy NGC 5077 reveal a gaseous structure along the minor axis. A spiral pattern and three central knots are present in the disk, while a faint gaseous structure on the western side runs almost parallel to the major axis of the stellar body. Based on observations at seven different position angles, four of which are our own, we find that the velocity field of the gas is consistent with that of an inclined circular disk, but the rotation axis is significantly misaligned with both axes of the light distribution. The stellar component shows little or no rotation, and the velocity dispersion is roughly constant at  $\sim 250 \text{ km/s}$  out to  $15\text{--}20 \text{ arcsec}$ .

The morphology and kinematics of the gas disk are used to probe the gravitational potential of the stellar body. Spherical, axisymmetric and triaxial models are considered. The intrinsic shape of the galaxy may well be nearly oblate, with the gas in a disk over the pole. The radial behaviour of the mass-to-light ratio  $M/L$  is derived.

**F. Bertola, D. Bettoni, L.M. Buson and W.W. Zeilinger (Italy): Counter-rotation in Dust-Lane Ellipticals**

Counter-rotation of gas and stars has been discovered in three elliptical galaxies which have dust lanes along their major axes. This dynamical decoupling of the two components together with that observed in minor-axis dust-lane ellipticals, where the two angular momenta are orthogonal, is the best proof of a second event, namely the acquisition of external material, in the history of dust-lane ellipticals. It is suggested that similar accretion events occur in SO galaxies giving rise to counter-rotating (and co-rotating) gas in the equatorial plane or to polar rings.

**B. Whitmore (USA): Rotation Curves for Spiral Galaxies in Clusters**

Rotation curves are presented for 21 galaxies in four large spiral-rich clusters: Cancer, Hercules, Peg 1, and DC 1842-63. Although the global properties (luminosity, radius, maximum rotation velocity, and mass) of the cluster sample are similar to those of the field, there is some evidence that the amplitude of the rotation curves in the cluster galaxies are lower than those of their field counterparts. A good correlation is found between the outer gradient of the rotation curve and the galaxy's distance from the center of the cluster, in the sense that the inner galaxies tend to have falling rotation curves while the outer galaxies, and field galaxies, tend to have flat or rising rotation curves. A strong correlation is also found between the  $M/L$  gradient across a galaxy and the galaxy's position in the cluster, with the outer galaxies having steeper  $M/L$  gradients. These correlations indicate that the inner cluster environment can strip away some fraction of the mass in the outer halo of a spiral galaxy, or alternatively, may not allow the halo to form.

**V.C. Rubin (USA): Rotation Curves for Spiral Galaxies in Compact Groups**

Long-slit CCD spectra and CCD images have been obtained for 50 spiral and E galaxies in 14 Hickson groups believed to be true associations. Many galaxies exhibit tidal peculiarities, both in their images and in their rotational properties. Some characteristic peculiarities will be discussed.

**E.M. Sadler (Australia) and S.M. Simkin (USA): Kinematics of Gas Disks in Radio Galaxies**

Spectroscopic velocity measurements (H $\alpha$ , [NII], and [OII]) have been obtained for the extended gas in several strong, Southern radio galaxies. These display a variety of non-circular motions superimposed on fairly regular circular velocity fields. In some cases, the peak, deprojected circular velocities exceed those for the brighter Sa galaxies.

**G.G. Byrd (USA): Triggering of Active Spiral Galaxies and QSOs in Rich Clusters**

In previous simulations of self gravitating spiral galaxies perturbed by nearby companions (Byrd et al. 1986, 1987, *Astron. Astrophys.*), we found that the perturbation levels in Seyferts observed by Dahari were also physically sufficient to create nuclear inflows of disk gas activity. We extend our simulations to include the effect of the gravitational field of a rich cluster on a galaxy just entering it. Disk and nuclear activity should be triggered in spirals within  $\sim 700$  kpc of the center of rich clusters like Coma. Tidal perturbation should be much more effective than ram pressure in triggering activity and changing spirals to SO's in rich clusters.

**P. Grosbol (FRG) and G. Contopoulos (Greece): Near Self-consistent Models of Spiral Galaxies**

The surface density response in a set of model spiral galaxies was compared with the imposed density to estimate the degree of self-consistency. It was confirmed that strong spiral structure can exist between the Inner Lindblad and the 4/1 resonance while the response outside this resonance for large amplitude generally is not well aligned with the pattern. The exact characteristics of the response is sensitive to the size of the bulge. The models show an arm segment which turns back to the center close to the 4/1 resonance. Further, the response outside the 4/1 resonance has a very patchy appearance. Similar features can be observed in galaxies like NGC 4535.

**W.W. Roberts and D.S. Adler (USA): Global Spiral Structure in Cloudy Gaseous Galactic Disks: the Need for and the Plague of Gravitational Softening in Computational Studies**

New questions are motivated through computational studies of cloudy gaseous galactic disks. Gravitational softening, although greatly needed on the one hand, is also a plague in disguise on the other. With too little softening, artificial instabilities can arise to drive unrealistic growth of random motions. With too much softening, important "nonlinear effects" of the self-gravitational gas can be suppressed. A delicate balance is necessary to capture the "multifold" role of the cloudy gaseous component in galactic disks. (This work was supported in part by NSF under Grants AST-82-04256 and AST-87-12084 and NASA under Grant NAGW-929.)

**S.T. Gottesman (USA): Constraints on the Properties of Spiral Galaxy Halos, as determined by the Kinematics of Small Satellite Systems**

We have observed a carefully selected sample of large spiral galaxies orbited by small, Magellanic-cloud like satellites. We have compared the orbital properties of the satellites with the rotational properties of the spirals. The ratio of these two independent mass estimates gives a disturbance which is significantly different than that found for binary galaxies. N-body modelling of our observation leads us to believe that our spirals have holes which are about four times the radius of their disks. Consequently, for our typical system, the isothermal halos are about four times more massive than the disks. The conclusion appears to be at variance with several strongly held beliefs concerning the structure of spirals.

6 August: Working Group on Supernovae

CHAIR: V. Trimble

Of the 24 papers proposed for this session, 17 were presented, most dealing with 1987A. K. Sato and P.J. Schinder agreed that the neutrino data can be fit with a range of equations of state and neutron star masses. The collapsing star could have been as early as BO.7Ia (with high N) to B31A (N normal), according to N.R. Walborn's re-examination of objective prism spectra. The possible early type and higher luminosity with require rethinking of light curve and spectrum interpretation.

Meanwhile, the spectrum synthesizers (R. Wehrse, J.C. Wheeler, and W. Schmutz) concurred that we need additional UV opacity and an envelope with both steep and flat parts in its density profile to account for the continuum and lines in early spectra. Given atmospheric models, these spectra imply a Baade distance of  $42 \pm 2$  kpc (R.V. Wagoner) vs.  $50 \pm 5$  kpc from other methods. Disturbingly, the implied distance drops with time.

Lots of molecular lines have turned up in the late time IR spectra. The CO requires the emitting region to have been enriched with C and O made in the progenitor (C.M. Sharp), but we so far have no evidence for dust, either circumstellar or made in the ejecta (E. Dwek). The mixing is only one sort of deviation from layered spherical structure that must have occurred early in 1987A. Infrared speckle data (A. Chababev) revealed complex extended emission from June 1987 onward. In addition, faint satellite emission components on many hydrogen lines and Na I were evident during days 20 to 100 and must somehow have been associated with lumpiness in the photosphere, because the velocity splitting of the inner edges of red and blue components tracked the contemporaneous photospheric speed (N. Suntzeff). We do not understand these lines.

Also still defying explanation is the soft X-ray flux, which, if attributed to ejecta colliding with circumstellar gas (H. Hanami), requires dense, red supergiant material to be closer to the star by a factor of 100 than the 0.3 pc implied by the narrow UV lines (P. Lundqvist). The non-detection of TeV gamma rays (T. Gaisser) is not precisely mysterious, but does limit cosmic ray acceleration to less than needed if supernovae are to contribute above  $10^{15}$  eV.

There are still supernovae other than 1987a in the universe, though perhaps not so many as we thought. H.E. Jorgensen reported first results from a search in clusters with  $z = 0.2$  that was expected to have found, so far, several SNI's, but was identified only one (probable) DNII, implying an SNI rate near the low end of the possible range of 0.2-0.8 SNe per century per  $10^{10} L_0^B$ . M. Nagasawa has been carrying out 3-d hydro-dynamic simulations of SNI's and finds that envelope is already shock break-out. Finally, N. Panagia reviewed the evidence that SN Ib's require a compact, low mass progenitor, surrounded by circumstellar material too dense easily to belong to it, and thus suggestive of a red giant - white dwarf binary.

There are two pieces of Working Group news: William Liller is now chairman, and R. Barbon and his colleagues at Asagio are updating their permanent SN catalogue to December 1988 and invite suggestions, comments, and corrections of earlier listings.

8 August: Working Group on Galaxy Photometry and Spectrophotometry

CHAIR: J.-L. Nieto

Dr. R. Buta (USA) was elected chairman of the Working Group for the period 1988 to 1991.

The following papers were presented:

**K. Kodaira (Japan): A New Parameter for Phase-space Density**

Using a homogeneous data set of 16E and 26s galaxies in the Virgo Cluster, we found a new parameter,  $f = (\text{GVD}^2)^{-1}$ , which has the dimension of phase-space density and shows an extremely tight correlation to the galaxy luminosity.



**K. Rakos (Austria): A Low-resolution (150 Å) Spectrophotometer for Galaxies**

In a joint project, J. Schombert, Palomar Obs., W.W. Weiss, Vienna Observatory and K.D. Rakos, Vienna Observatory, a special spectrophotometer is now under construction. Two field lenses with focal ratio of  $f/2$  concentrate the light of the galaxy and of the local sky as two images of the main mirror on the silica fiber light guides. The fibers are formed to a single slit and a holographic concave grating corrected for spherical aberration and flat image with a focal ratio of  $f/2$  forms an image of the spectrum on a CCD camera the spectrum from 3500 Å to 6000 Å can be folded by any filter transmission curve to get the photometry in the selected photometric system. The calibration of the spectrum can be easily made observing spectrophotometric standards. The proper sky subtraction is very simple because the sky spectrum is recorded simultaneously.

**H. Lorenz (DRG): Adaptive Digital Filters applied to Surface Photometry**

An adaptive filtering technique to the two-dimensional photometric mapping of extended objects has been presented. The key feature of this system is the "H-Transform". By comparing the results to recent studies of NGC 3379 (Capaccioli et al., 1988; *Astron. Nachr.* 309, 69) no systematic errors in the reduction procedure could be found. The mean residuals are smaller than  $\pm 0.05$  at a threshold of 1'1 of the night sky level.

**J.-L. Prieur (France), D. Carter, A. Wilkinson (UK), W.B. Sparks (USA) and D.F. Malin (Australia): A Statistical Study of Shell Galaxies**

Preliminary results of an extensive CCD Survey of Malin and Carter's catalogue (1983, *Ap. J.* 274, 534) have been presented. Shell photometry and morphology are in agreement with the expectations of the merging models. A correlation has been found between the morphology of the shell system and the apparent flattening of the parent galaxy. Significant color differences have been measured along some of the shells. Recent massive nuclear star formation which has probably been triggered by the collision with the companion galaxy, has been discovered in about 20% of these objects.

**E. Sadler (Australia) and J.S. Gallagher (USA): Star-forming Regions in Small Elliptical Galaxies**

Many small ( $M_B > -17$ ) elliptical and SO galaxies show evidence for current star formation. The star-forming regions are blue clumps with HII-region-like spectra and usually lie in the central 1–2 kpc of the galaxy. Broad-band ( $B, R$ ) profiles show that these are true E/SO galaxies, not misclassified spiral or irregular systems. Thus the recent star formation history of small ellipticals appears to differ from that of more luminous early-type galaxies.

**F. Bertola (Italy), M. Vietri (Italy) and W. Zeilinger (Italy): A Search for Triaxial Bulges**

A wide sample of spiral and SO galaxies has been investigated photometrically, using CCD images obtained with the ESO telescopes in order to detect possible misalignments between the major axes of the disk and of the bulge. This phenomenon, once the effects of dust are removed, is an evidence that the bulge has a triaxial shape, as it is the case of elliptical galaxies. A fair fraction of our galaxies shows such a twisting. The photometric data, when coupled with the kinematical ones, describing the distortions in the velocity field of the gas in the disk induced by the triaxial potential of the bulge, allow to establish with a high degree of certainty, the axial ratios of the bulge.

**P. Prugniel, E. Davoust and J.-L. Nieto (France): Eight Hierarchical Pairs of Elliptical Galaxies**

We investigated the photometric and spectroscopic proportions of a sample of eight closely interacting pools of elliptical galaxies whose mass ratio is of the order of 10 or higher. A special algorithm allows us to disentangle the contributions of the two galaxies on the images, so that their photometric properties can be known. From (mean surface brightness, absolute magnitude) and (velocity dispersion, absolute magnitude) diagrams, we discuss the evidence for tidal heating in these pairs.

**W. Jaffe (Netherlands): The Formation of the Structure of Elliptical Galaxies**

In continuation of previous work we show that it is easy to reproduce the form of elliptical galaxies by any process that scatters the energies of individual stars by large amounts. Both the envelopes and the bodies are well reproduced. We also show that even small scattering processes with  $\Delta E \propto E^{1/2}$  ma/u

nice ellipticals, and tidal heating in clusters satisfies this condition. We consider some of the consequences of this model to the statistics and evolution of galaxies and dark halos in clusters.

**Hong Bae Ann (Korea): Luminosity Distributions in Barred Galaxies**

The luminosity distribution of  $3\rho$  barred galaxies were investigated by a new method of profile decomposition, assuming exponential function and Gaussian function along and perpendicular to bar. The fractional luminosity of bar ( $B/L$ ) increase with spheroid-to-disk value ( $S/D$ ) for galaxies with  $S/D$  less than 1. About 75% of the observed galaxies have  $B/L$  less than 0.1.

**D. Bettoni and G. Galletta (Italy): Peculiarities in Barred S0s**

Some peculiarities have been found analysing CCD images of barred S0 galaxies. They are:

- a) in FNO systems, NGC (6684 and NGC 2983, the bar is shifted by few ( $\sim 2$ ) arcseconds with respect to the disc isophotos.
- b) rings appear to be elliptic, like in the case of NGC 6684.
- c) Pseudo spiral arms (composed of stars) appears in some systems.

**E. Anathassoula, S. Morin, D. Puy, H. Wozniak, A. Bosma, M. Pierce, J. Lombard (France): The Shape of Bars in Early-type Barred Galaxies**

We have examined the shape of bars in a small sample of SB0 galaxies with strong bars by fitting generalised ellipses [ $(\frac{x}{a})^c + (\frac{y}{b})^c = 1$ ] to be isophotes. These represent good fits and show that these bars are more rectangular like than elliptical like. The shape parameter  $c$  has a maximum near the end of the bar and the values of the maximum range between 2.7 and 5.3. The ellipticity decreases with radius starting from a maximum value around 0.8 which corresponds to an  $a/b$  of the order of 5.

**R. Buta (USA): The Nature of Rings in Early-type Disk Galaxies**

Early-type disk galaxies some of the most spectacular examples of ring phenomena among the population of normal, mostly non-interacting galaxies. In S0 galaxies these rings are most prominent at stage S0<sup>+</sup>, and some of the brightest examples occur in systems possessing very weak bars or no obvious bar at all. In the absence of strong bars and significant amounts of gas, the theory implies that it would be difficult for rings to have formed in these kinds of galaxies. Therefore, ringed S0 galaxies pose a dilemma for ring formation theories that makes their properties worth exploring more carefully.

For this purpose, the surface brightness and color properties of six early-type ringed galaxies have been explored using multi-color CCD surface photometry. The sample includes two "normal" barred spirals, NGC 1350 and 139, a weakly-barred S0/a system, NGC 3081, and three "non-barred" S0<sup>+</sup> systems, NGC 7020, 7187 and 7702. The results show (1) that the rings in all of these objects are zones of enhanced blue colors regardless of whether a bar is present or not; (2) that the best defined rings have old stellar components, while the most-spiral-like ring (in NGC 1398) has no very significant stellar component; and (3) that rings and lenses are intimately connected, rather than distinct phenomena. In general, the rings of early-type disk galaxies share much in common with those of later-type barred spirals, and are probably related to the same resonances.

8 August: Stellar Photometry with Modern Array Detectors

CHAIR: F. Rufener

The proceedings of the Joint Commission Meeting are contained in the report of Commission 25.

8 August: Galaxy Redshift Determinations: Better Techniques, Better Standards

CHAIR: J. Huchra



9 August: New Results

CHAIR: G.A. Tammann

**P. das Gupta and J.V. Narlikar (India): Counts of Radio Galaxies and Evolution**

This work follows the earlier investigations of Das Gupta, Narlikar and Burbidge (1988, A. J. Jou. p. 5) in which a non-evolving radio-luminosity function (RLF) was constructed from the observed number-redshift diagram for a complete sample of radiogalaxies in a given friedman universe. Using the  $\chi^2$  and Kolmogorov-Smirnov (KS) tests it was shown that the non-evolving RLF cannot be ruled out on the basis of redshift ( $z$ ) – flux density ( $s$ ) plot.

Here a similar analysis is carried out for the steady state model for the 3C–R and 2.7 GHz complete samples of radio galaxies. The  $\chi^2$  and KS-test are shown to give a consistent result between the theoretical and observed  $z - s$  plots. These tests and the  $V/v_m$  test does not rule out this model.

**Y. Sobouti (Iran): Symmetries of Liouville's Equation**

Liouville's and linearized Liouville-Poisson's equations have  $O(3)$  symmetry. There exists an angular momentum operator,  $J$ , in phase space which commutes with operators of these equations.  $J$  is the sum of two angular momenta in configuration and momentum spaces. This enables one (a) to classify the normal modes by the eigennumbers of  $J^2$ , and  $J_z$ , and (b) to extract the dependence of the normal modes on direction angels of the position and momentum vectors, analytically.

**T.K. Chatterjee (Mexico): Frequency Determinations of Peculiar Galaxies on a Dynamical Basis**

A study of the expected frequency of all sorts of peculiar galaxies is conducted by studying galactic collisions with varying collision parameters. Results indicate that the expected frequency of such galaxies is compatible with the observational value only if it is measured with respect to densely populated regions, using the average values of the parameters corresponding to such regions, while it falls by several orders of magnitude if we consider regions of normal density for its determination. This leads to the conclusion that most of these peculiar galaxies must have already been bound doubles, whose orbits are such as to have brought about only now the close proximity characteristic of such systems.

**C.-K. Chou (China): The Properties of Spiral Density Waves in a Magnetoactive Disk**

The propagation of spiral density waves in a differentially rotating, self-gravitating, magnetoactive and highly flattened disk is investigated by using the asymptotic theory for tightly wound spirals developed by Lin and his collaborators. We adopt the continuum fluid model as the primary basis, and out treatment will be largely analytical.

A new asymptotic dispersion relation for spiral magnetoacoustic waves with magnetic fields along the spiral arms  $B_\theta(\gamma)$  is derives in the frozen-field approximation. We also present a more exact local dispersion relation by using the WKB approximation and study the effects of magnetic fields on the growth rate.

The stabilizing effect of the magnetic fields is spiral galaxies ( $V_A^2/a^2 \simeq 0.06$ ,  $V_A =$  Alfvén speed,  $a =$  speed of sound) is rather small. However, the field strength in solar nebula or HII regions may be considerably stronger so that  $V_A^2/a^2 \simeq 0.1$  to 1. It is then expected that larger effects may result.

**M. Tagger, J.F. Sygnet and R. Pellat (France): Bars and Barred Galaxies: Linear Theory Revisited**

We reconsider the shearing sheet model of a flat disk galaxy. We show by asymptotic expansions that the global solution contains not only the usual tightly wound waves of Lin and Shu, but also a distinct, bar-like feature. Its presence, related to the Swing amplification mechanism, is due to the thin-disk nature of the galaxy. The bar feature is dominant when and where the galaxy is hot.

**M. Kaufman (USA): M81: Tests of Common Notions about Grand Design Spirals**

Although M81 is a classic density wave galaxy and the HI velocity contours show a spiral shock front, M81 does not have certain properties often attributed to grand design spirals. For example, the nonthermal

radio arms are generally centered on the gravitational potential minimum, not on the velocity shock front. The dust lanes near the velocity shock front have neither greater length nor greater extinction than those farther downstream. The giant radio HII regions are located either near or downstream from the potential minimum. The observed cross-arm distributions of dust, etc. can be understood within the context of density wave models: certain properties of spiral arms depend sensitively on the amplitude of the density wave compression or on the cloudy nature of the interstellar medium.

**I.A. Issa (Egypt): A Geometric Method to Determine the Distances of Galaxies**

**T. Storchi-Bergmann and M.G. Pastoriza (Brazil): Low Activity Nuclei with Strong [NII] Lines**

We present results from the study of the spectra of four low activity Seyfert 2 nuclei, a LINER and one of intermediate type between the two. All of them present strong [NII] $\lambda\lambda 6548+6584$  emission lines. The analyzed of the absorption spectrum showed that more than 80% of the light comes from old population stars ( $10^{10}$  years) with average metallicity two times solar. We have compared the relative intensities of the emission lines with values obtained from model nebulae photoionized by a non-thermal continuum, having solar and two times solar abundances. We have concluded that the models can reproduce the line intensities for the LINER galaxy, but for the Seyfert 2 galaxies, the only way to reproduce the [NII] lines is considering an overabundance of nitrogen relative to the other elements of about 3 times solar.

**U.C. Joshi (India): Polarimetry of Seyfert Galaxies NGC 2992, 3081, 3227 and IC 4329**

**J.J. Steyaert (Belgium): Energy Generation in Quasars**

A new scheme, including new physics is proposed that could power quasars. It is based on a new class of nuclear reactions of cross-section about  $10^{-33}$  cm<sup>2</sup>. A mass of  $10^{11}$  M<sub>⊙</sub> <sup>3</sup>He gas is transformed in  $10^8$  years into D and <sup>4</sup>He with luminosity of  $8 \cdot 10^{46}$  erg s<sup>-1</sup>. A variability within 1 month is obtained if the density is  $10^9$  atoms/cm<sup>3</sup>, a value consistent with CIII] data. The scheme could be used also for active galaxies and suggests an elemental evolution of pre-quasars, quasars and galaxies with time. Data from SN 1987A absorption lines were deconvolved using the same scheme.

**I.F. Mirabel (USA): Arecibo HI Survey of the 100 most Luminous IRAS Galaxies of the Local Universe**

**M.F. Struble (USA): The "Starpile" in Abell 545**

I report the first probable visual discovery of intracluster matter (from POSS): a low surface density feature in the second richest Abell cluster, A545. Galaxy counts show it is located at the cluster center. The feature has  $B - V \sim 1.3$  to 1.5, the same as an elliptical galaxy at cluster  $z$  of 0.15, is  $\sim 70$  kpc  $\times$  40 kpc and has at least two faint nuclei. Several galaxies, some binary, are located at its northern periphery. Its color and central location argue against an interstellar feature superimposed on the cluster. It is most similar to a cD galaxy's envelope (no nucleus).

**S.P. Bhavsar (USA): First Ranked Cluster Galaxies: A Two Population Model**

The small dispersion in the absolute magnitudes ( $\sim 0.35$  mag) of first-ranked galaxies in rich clusters has been the cause for much debate between the "special" and "statistical" hypotheses for these galaxies. We present statistical evidence that it is not the one or the other but a combination. The distribution in magnitudes of the brightest galaxies is best explained if they consist of two distinct populations of objects; a population of special galaxies having a Gaussian distribution of magnitudes with a small dispersion (0.21 mag), and a population of extremes of a statistical luminosity function. The best fit model requires that 63% of the clusters have a special galaxy that is on an average 0.48 magnitudes brighter than the brightest normal galaxy. The model also requires the luminosity function of galaxies in clusters to be much steeper at the very tail end, than conventionally described.

**R.A. Windhorst (USA): Discovery of a Nearly Normal Elliptical Galaxy at  $z = 2.39$**

Data is presented on a faint galaxy that is probably a nearly normal elliptical at a redshift of 2.39. The galaxy was found on a Palomar 200 inch Four-shooter image, and is the  $V \sim 23.5$  mag OPTICAL counterpart of the steep special compact, 50 mJy radio source Herc 202 from the Leiden-Berkeley Deep Survey. The object is barely extended (FWHM  $\approx 1''.6$ , total extent  $\approx 2''.6$ ) and has fairly blue colors (Gunn  $g - r = 0.03$ , or  $B - V \sim 0.5$  mag). It was detected in one night of integration time with the

200 inch IR systems at  $H (1.6\mu) = 20.8$  mag. I spent one night at the MMT and two nights with the MAYALL 4 meter CRYOCAM to measure its spectrum at  $15 \text{ \AA}$  resolution, and found very weak ( $\lesssim 2 \times$  continuum), unresolved emission lines ( $\text{Ly}\alpha$ , CIV, CIII, and perhaps CII  $\circ$  HeII), all consistent with  $z = 2.390 \pm 0.003$ . The optical and optical-IR colors, as well as its optical morphology, are consistent with a passively evolving (giant elliptical galaxy with age  $\simeq 1\text{--}2$  Gyr at  $z = 2.39$  (or current age of  $\sim 14$  Gyr if  $H_0 = 50$ ,  $q_0 = 0.1$ ). Although the galaxy was selected as radio source, it is a  $20\text{--}100 \times$  weaker radio source than the extremely low surface brightness protogalaxy candidates in the 3CR and 1 Jy samples, discovered recently at similar redshifts. While those objects are possibly protogalaxies, whose formation might be triggered by their extremely powerful radio jets, Herc 202 has fairly compact optical morphology (visible size of  $20\text{--}30$  kpc), *no* strong emission lines, and a continuum consistent with that of a normal elliptical galaxy redshifted to  $z = 2.4$ .

I believe that Herc 202 is the closest one can get with the currently available detector technology and telescopes to find (nearly) normal elliptical galaxies at  $z > 2$ . The current radio source sample has 451 radio sources with 21 cm fluxes down to  $50 \mu\text{Jy}$ , and imaged with Fourshooter down to  $V > 23$  mag. In this sample, there are another 200 radio galaxies with  $V > 23$  mag, and several dozen more candidate like Herc 202.

R.W. Hunstead (Australia), M. Pettini (Australia), A. Boksenberg (UK) and A.B. Fletcher (Australia):  
**A Possible Primeval Galaxy at  $z = 2.5$**

QSO absorption systems in which the Lyman  $\alpha$  profile shows damping wings have been interpreted as the HI disks of young intervening galaxies. Studies of heavy element enrichment in one such system ( $z_{\text{abs}} = 2.309$  towards PHL 957) indicates an abundance of only  $1/20$  solar with very little evidence for dust. In another system ( $z_{\text{abs}} = 2.465$  towards Q0836+113) we find narrow ( $\leq 50$  km/s FWHM) Lyman  $\alpha$  emission in the base of the damped Lyman  $\alpha$  absorption line. The star formation rate inferred from the Lyman  $\alpha$  luminosity may be as low as  $1 M_{\odot}/\text{yr}$ .

#### 9 August: Star Clusters in the Magellanic Clouds

CHAIR: P. Demarque

The proceedings of this Joint Commission Meeting are contained in the report of Commission 37.