Report on

The visit of Prof R. Sunyaev to ESO/Chile and the Topical Meeting "Accretion onto Compact Objects"

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Over the period April 4 to April 17, we had the great pleasure of the visit of Prof. Rashid Sunyaev in Chile. This was an opportunity for him to visit some of ESO's facilities (Paranal, Santiago) as well as APEX, and also to pay a visit to the new facilities of our colleagues in La Serena (among others Magellan and Gemini).

For us, it was an opportunity to organize discussions and meetings to make use of his vast experience in the field of cosmology and high energy astrophysics.

On this occasion we held a Topical Meeting in Santiago, on April 15, on the subject of: "Accretion onto Compact Objects". About 30 participants attended the Meeting, among them many students from PUC and from ESO. Presentations ranged from theory (the theory of accretion, the evolution of low-mass X-ray binaries and millisecond pulsars controlled by gravitational radiation, the mapping of eccentric orbits in triaxial log potential, …) to observational results (echo-sounding in X-ray binaries, warped molecular gas around AGN, formation of high mass stars via accretion, …).

Theoretical problems in astrophysics are discussed only occasionally in Chile, as the astronomical activity is really dominated by observational subjects thanks to a top-level suite of telescopes. So, this provided an interesting change and gave new perspectives to the young audience at the *Topical Meeting*.

Report on the ESO Conference:

Planetary Nebulae beyond the Milky Way

J. R. Walsh and M. Rejkuba (ESO)

This three-day ESO workshop, held from 19 to 21 May 2004, devoted to extra-galactic planetary nebulae (PN), was the first full workshop on the topic. Previously there had been discussions of extra-galactic PN on the final day of the pentennial IAU Symposium on Planetary Nebulae (last held in Canberra in 2001) and a one day meeting during the IAU General Assembly in den Haag in 1994. The field has expanded considerably in the last decade with many PN now detected in Local Group galaxies, extensive surveys underway in nearby early-type galaxies and in the intergalaxy regions of galaxy clusters, together with the use of PNe as kinematic probes for galaxy potentials. There are currently many thousands of PN catalogued in external galaxies, far surpassing the approximately 1500 known in the Milky Way.

Alan Moorwood, Head of Instrumentation at ESO, in his welcome address presented a reflection from his attendance at a PN Symposium in New York in 1977. He noted that the order of the first few talks at this workshop – on surveys in the Magellanic Clouds and Local Group galaxies – was similar to that 27 years before.

However after a few talks, Alan had to agree that a lot had happened in the field since 1977! There were 16 invited reviews, 26 contributed talks and two discussion sessions over three full days, and also 13 posters, for a total of 65 participants. We present a selection from among the topics. Since all the speakers presented their talks in electronic form we collected them together after the conference and made them available linked to the items in the conference programme at http://www.eso.org/gen-fac/meetings/extgalpn04/programme.html where the reader is referred for more details.

The first extra-galactic PN were those discovered in the Magellanic Clouds and surveys are still on-going. G. Jacoby (WIYN) suggested that all the PN had been probably been discovered in the SMC, whilst many more remain to be discovered in the LMC. The cumulative plot of the number of PN against the magnitude in the [OIII] 5007Å line – known as the PN Luminosity Function (PNLF) – showed a dip at about four magnitudes below the peak for the SMC (see Figure 1). This was subsequently referred to as "Jacoby's deficit". The photographic Hα survey of the UK Schmidt Telescope in Australia is still discovering many more LMC PN. W. Reid (MacQuarie University) showed how the Hα and matched *R*-band images are differenced to reveal more than a thousand new PN candidates in the LMC, which are then followed up with multi-object fibre spectroscopy on the AAT.

In other Local Group galaxies the census of PNe conducted with the Wide Field Camera at the Isaac Newton Telescope was presented by R. Corradi (ING). Local Group dwarf galaxies were surveyed in various narrow and broad filters and the images are reduced and publically available. L. Magrini (Firenze), P. Leisy (ING) and collaborators discussed spectroscopy of some of the candidates from this survey. The census of PN in the Local Group is complementary to various Asymptotic Giant Branch (AGB) stellar surveys which were summarized by M. Groenewegen (Leuven). The AGB surveys form not only an important test of stellar evolution models, but also an excellent tool for studying chemical evolution of dwarf galaxies.

Deep surveys in nearby galaxy clusters such as Virgo and Fornax reveal the presence of true intra-cluster PN. J. Feldmeier charted the discovery of these objects. The early surveys were beset by interlopers, mostly z=3.1 Lyman-alpha galaxies; but later surveys with spectroscopic follow-up (detection of the [O III] 5007,4959Å doublet allows clear discrimination from background emission line objects) are revealing numbers of PN wandering in the spaces between galaxies. The intra-cluster PN have enormous potential for studying the number, origin, metallicity and kinematics of the intra-cluster stars. Current estimates suggest that about 15% of cluster stellar mass may reside in intra-cluster stars. Multi-fibre instruments on large telescopes show that it is feasible to measure the kinematics of the intra-cluster PN and M. Arnaboldi showed some Virgo PN spectra recently taken with FLAMES on the VLT.

The PNLF is now an established secondary distance indicator and R. Ciardullo in his review showed that the first suggestion that PN could be used as distance indicators was made in 1966. It was not until the 1990's that the PNLF was routinely applied to nearby early-type galaxies. The method works comparably well to surface brightness fluctuations with very little dependence on metallicity of the galaxy. The next challenge for the observers is to compare the PNLF constructed from Hβ and other lines with the [O III] 5007Å PNLF.

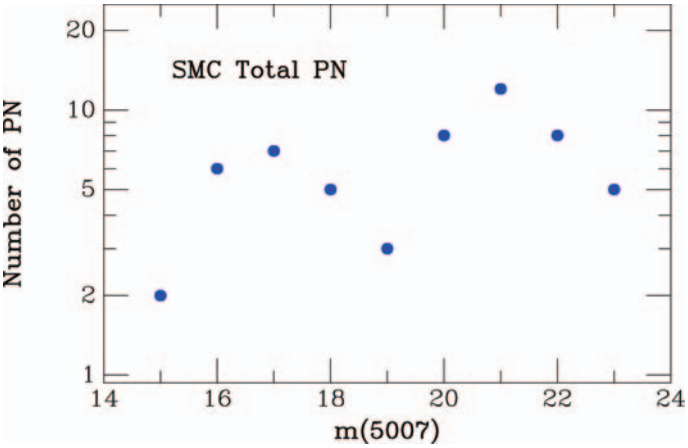

Figure 1: The Planetary Nebula Luminosity Function (PNLF) is shown for the Small Magellanic Cloud. This was presented by G. Jacoby and, given that searches for PN beyond 5007Å magnitude of 23 have failed to find further PN, it is suggested that this PNLF may be complete.

L. Girardi (Trieste) showed the advances in modelling PN evolution, but also the enormous difficulties and lack of a complete theoretical understanding of the PNLF.

R. Shaw, L. Stanghellini and E. Villaver (NOAO) presented different aspects and science from the high resolution HST survey of PN in the Magellanic Clouds. The high resolution slitless spectroscopy with STIS has enabled the study of expansion ages, connection of morphology to environment and the central star progenitor properties, such as winds and transition times, enabling tests of stellar and PN evolutionary models by placing the PN central stars in the HR diagram.

One of the aims of the conference was to draw-out the links of extra-galactic PN with other stellar indicators of galaxies and one session was devoted to the stellar connection, focussing on Asymptotic Giant Branch (AGB) stars, the progenitor stage to PN, and the stellar parameters of PN central stars. On the theoretical side, L. Willson (Iowa State) showed the complexities of mass loss on the AGB and how difficult is its parameterization.

One stumbling block to applying the classical abundance determination methods for emission line spectra is the, sometimes large, difference in the PN abundances derived from the optical recombination lines for O and Ne, for example, with those derived from the much brighter collisionally excited (forbidden) lines, such as [O II] 3727Å and [O III] 5007Å. X. Liu (Peking) showed that for some PN the discrepancy between the forbidden and recombination line abundances can reach a factor of ten. However the likely reason is that cold, metal-rich, clumps, with a small fraction of the gas mass, make a strong contribution to the recombination lines, whilst the majority of hotter and lower abundance gas produces most of the forbidden line emission. The metal-rich intrusions may be ejected by the star at late evolutionary stages or may even be planetismals within the ionized region. The bright collisionally excited lines are used to derive metal abundances and various talks discussed O abundance determination in NGC 6822, Sextans A and B and M33 extending out to NGC 5128 (3.5Mpc) and NGC 4697 (10Mpc). For the latter galaxy, R. Mendez (Univ. Hawaii) showed a comparison of the long-slit integrated stellar light metallicity with PN metallicities. These results suggest metallicities with large dispersions in the halos of ellipticals. With 8–10m class telescopes determinations of O, He, N, Ne, etc. in PN become feasible and large samples can be achieved with multi-object spectrometers, enabling studies of abundance gradients at large galactocentric radii.

The final day of the conference was almost solely devoted to dynamical studies of galaxies using the PN as probes. On account of their strong line emission (in particular the [O III] 5007Å line) and the narrowness of the lines (typically < 30 km/s), PN make ideal tracers of the gravitational potential of a galaxy to large radii, where the integrated stellar light has surface brightness too low for detection. N. Douglas (Katpeyn Laboratory) described the work done by the Planetary Nebula Spectrograph (PN.S) group. This dedicated instrument provides detections and radial velocities in a single observation. Large samples of PN have been collected with the PN.S and detailed kinematic modelling is being undertaken. A. Romanowsky (Nottingham) showed the results of modelling PN kinematics for the ellipticals so far studied (most with low X-ray luminosity) by the PN.S team. There appears to be little evidence for dark matter (*M/L* stays low even at 6 R_e – see Figure 2) as also discussed by O. Gerhard (Basel) and N. Napolitano (Kapteyn Laboratory). Ideally samples of about 1000 PN are required per galaxy for detailed modelling of the components of the potential. For M31, velocities for over 2700 PN have been measured with the PN.S and H. Merrrett (Nottingham) described the mapping of the various halo components, including the dwarf galaxies NGC 185 and 205. Comparison with the M31 stellar RGB kinematics was presented by A. Ferguson (MPA, Garching).

During the conference there were several "mini-workshops": one on M 31 as mentioned above and another on NGC 5128 which has over 1100 PN candidates and almost 800 confirmed. E. Peng (Rutgers University) presented extensive kinematic modelling, and studies of the AGB stars (M. Rejkuba) and abundance measurements of the PN (J. Walsh) were also discussed. There were two scheduled discussion sessions on "Observational Challenges" and "Future Challenges" at the end of the second and third days respectively.

With so many PN now known in galaxies beyond the Milky Way some standardization of the nomenclature is desperately required. This topic formed part of the first discussion session and was in fact triggered by an enquiry from a German amateur astronomer.

The meeting concluded with a conference summary by H. Ford (Johns Hopkins). He very bravely commented on every talk, with collages from the presentations and digital photos of the speakers. Many people contributed to the lively meeting: the SOC and in particular Letizia Stanghellini who co-chaired; Nausicaa Delmotte helped with the web pages. The smooth running of the conference organization was almost entirely due to Christina Stoffer, with Britt Sjoeberg helping out on the public holiday.

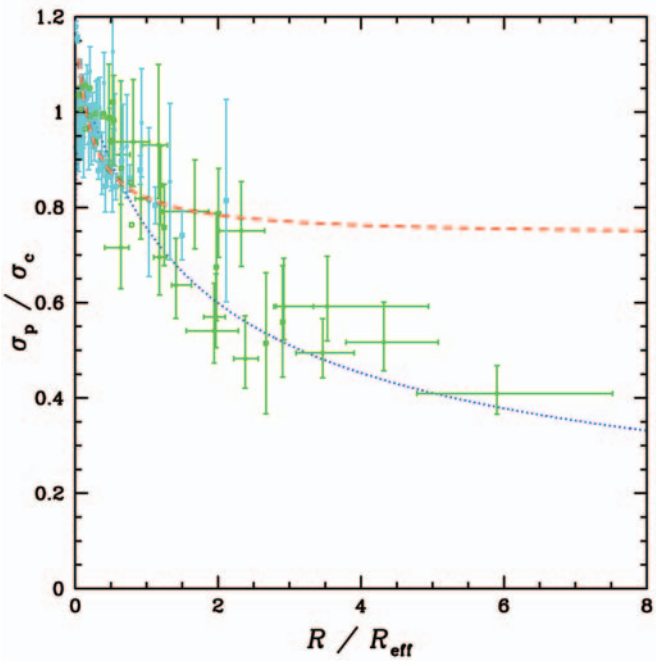

Figure 2: The observed velocity dispersion, scaled to that at the centre, derived from the PN is shown as a function of effective radius for four early type galaxies (NGC 821, 3379, 4494 and 4697) from the presentation of A. Romanowsky. The horizontal dashed line (red) is the result of a model based on an isotropic isothermal halo and the dotted blue line an isotropic constant *M/L* Hernquist model. The absence of increasing *M/L* suggests that any dark-matter halo must make a minor contribution in these galaxies.