Mem. S.A.It. Vol. 79, 1330
© SAIt 2008
Memorie della

Concluding remarks

Thierry J.-L. Courvoisier[1,2]

[1] ISDC 16, ch. d'Ecogia CH-1290 VERSOIX, Switzerland
[2] Department of Astronomy University of Geneva 51, ch. des Maillettes CH-1290 SAUVERNY, Switzerland
e-mail: thierry.courvoisier@obs.unige.ch

Abstract. We go over some of the results that were presented during the conference, with no claim for completeness or for any other selection criterion than personal prejudice.

The central regions of galaxies steadily gain in importance as the location of important astrophysical activity. They have been studied for decades in the frame of Active Galactic Nuclei (AGN) on one side, while the center of our Galaxy has been the object of intense study across the whole of the spectrum leading to the remarkable measurement of the mass of the black hole there and its also remarkable lack of activity on the other side. The centers of many galaxies have more recently been found to host large and rather inactive black holes (or at least large mass concentrations) intimately related to the bulge of the galaxies. It has also been shown in many studies that the evolution of activity in galaxies with time as the Universe grows older is closely related to the star formation activity. In short, the central kiloparsec of galaxies seems to harbour a phenomenology that is deeply connected to many aspects of star population evolution, galaxy properties and also the energetics of the gas in large clusters of galaxies.

Despite the importance of the physics in the central regions of galaxies in so many astrophysical contexts, the physics of the nuclei is still ill understood. We must understand why and how black holes of the same mass have luminosities that differ by many orders of magnitudes (see a healthy Seyfert galaxy on one side and Sgr A^* on the other). We must understand how AGN emit over the whole electromagnetic spectrum in such a way that all the components seem to emit roughly the same luminosities (the reason for which hot dust radiates the same energy as relativistic electrons in a magnetic field as is observed in 3C 273 escapes my understanding). We must also understand what makes this emission vary on many timescales. Once this is understood we must still understand why the AGN phenomenology appears in so many different guises that we had to develop a whole zoology to classify the observational results. Orientation alone is not a sufficient explanation.

Many of the topics that were discussed at this conference have been the subject of work for many years. This is true of the broad line regions, the relationship between disk and jet, the existence of disks, how much of the phenomenology can be explained by disk related effects. The originality of the conference is therefore not to be found in the topics covered, but rather in the way in which the topics have been discussed, free of the chapel spirit that

Send offprint requests to: T. Courvoisier sometimes stiffens progress. Among the many interesting points made during the conference, I would like to emphasize some, the choice being due to a large extend to my approach to the subject, rather than to some absolute measure of interest.

M. Gaskell showed how reflection of line photons on infalling clouds can lead to the observed systematic blue shifts. It is also interesting to see how very detailed and careful spectropolarimetric observations of lines give a clear view of the gas movements (D. Axon). Further inferences from the lines were made in several contributions, e.g. by H. Netzer who could deconvolve AGN from star formation activity or when S. Butiglione found no correlation between the line properties and the jet properties, which she interpreted as the absence of link between disk and jet observed properties. While radio observations of jets have become very impressive, it was sobering to hear that even the best angular resolution that can be expected from space VLBI will not resolve the disk-jet interface (A. Lobanov). Interesting also the remark that there are stationary jet components, i.e. not everything that shines moves along the jet (T. Arshakian).

It was stressed that while energy can be efficiently extracted from Kerr black holes close to maximal rotation (M. Camenzind), analysis of the black hole mass evolution requires that the black holes be only slowly rotating (A. King). A. Merloni added to this discussion by showing that globally the radiation efficiency of the accretion process is around 0.06, also arguing in favour of generally slow black hole rotation. Looking at the influence of the AGN on its surrounding, A. King also made the point that momentum be considered rather than energy, as the latter can be (is) dissipated and radiated thus disappearing from the energy balance. Momentum provides therefore a more direct link between the AGN and the induced phenomenology in the near and far surroundings.

M. Elitzur showed how much of the AGN phenomenology can be explained with disks and related objects (e.g. matter evaporated from the disks). One may then wonder whether disks and jets are the only relevant ingredients, a view that I challenged by introducing shocks to explain the UV and X-ray phenomenology of AGN. The link between the disk related physics and the gas at larger distances (as observed in HI, F. Israel) is also a subject that requires more attention.

When looking at the evolution of black hole masses and the respective importance of mergers and accretion, M. Volonteri remarked that since the total mass into black holes grows over cosmological times, accretion must play an important role, even if mergers cannot be neglected (N. Bennert). It is worth remembering, though, that black hole mass measurements do have their difficulties and should not always be taken without a critical eye (D. Batchelor).

There is an immense richness in the phenomenology observed in the central kiloparsec of galaxies. Making sense of all the observations is likely to show that the images that we have been developing over the last few decades are probably much oversimplified. Conferences like this one have the strong virtue to bring people with rather different approaches to these objects, forcing to recognize the diversity of the processes at work and their interconnections. The constructive and friendly discussions that took place throughout the conference allowed certainly all the participants to move forward. The organizers should be heartily thanked for providing a fruitful and very convivial atmosphere and the contributors for bringing the substance for progress.

References

All the names mentioned in this summary refer to contributions presented at the conference and to be found in these proceedings.