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GPS/CSS Workshop — Concluding Remarks

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I begin with the main new facts, of which perhaps the most important are the very low apparent ages of some radio galaxies.

Most of us believe that these young radio galaxies ultimately evolve into FR II and, as a function of interstellar and intergalactic density, perhaps also into FR I radio galaxies. Questions remaining include *are there too many small CSO?*, *what is the origin of the faint material one sees in or around these young sources?*, *is this the result of prior activity?* and *evolution models tend to assume constant jet power, but is this true?* We certainly see evidence for intermittency: In 1245+676 an age of a few centuries was found, but there is also a Mpc-scale source which cannot be less than some 10 My old. What happened in between? How long does a radio galaxy take to begin: a day, a year, a century? Is the beginning related to the arrival of some gas near the central black hole, followed by a process of self-regulation? To answer some questions we need better volume-limited samples than those available today, so that the space density of objects as a function of luminosity, size and apparent age may be ascertained. What could provide some confidence that these ages are real is the remarkable agreement, reported here, between kinematic ages and spectral ones. However, it has to be noted that the latter depend on equipartition assumptions, including a particular proton-to-electron ratio — If the magnetic field was four times weaker, the spectral ages would increase by a factor of eight.

A very different discovery pertains to the scintillating sources, which must have angular sizes at the μas level corresponding to brightness temperatures of 10^{14} K. These sources have significant circular polarisation, with an uncertain interpretation.

Of course, many other new and interesting results were reported, on X-ray jets and X- and H I absorption, among others. Since the latter depends on the spin temperature, which is a function of the physical conditions in the absorbing medium, the comparison with the X-ray absorption gives information on these conditions. There is still uncertainty in the resulting models: the pressure is usually treated as a more or less free parameter, and in a molecular medium the chemistry depends on the dust, which may well be different in these dense media.

Outflow is frequently seen in AGN, but where is the inflow? Not only for the energy production but also for the star formation, which is sometimes observed, and to compensate for the outflow, matter has to come from somewhere. Was all of this brought in during a merger event or are there more complex flows? In this connection, it has repeatedly been pointed out that a large degree of uncertainty results from the fact that systemic redshifts may only be determined reliably from stellar absorption lines, since the emission line gas partakes in these flows. The importance of these flows in the energetics remains rather uncertain, but with radio, X-ray and IR data now available at least the bolometric luminosities have become clearer. They also reveal other mysteries: We think of NGC 1068 as a typical Seyfert Galaxy, of Cyg A as a particularly powerful radio galaxy. Nevertheless, their bolometric luminosities are not very different. We still do not fully understand why only sometimes so much of the energy goes into the radio channel.

Finally, the 'eternal issues':

Shocks versus photoionisation. As the practitioners age, they seem to become more tolerant and to agree that even though one is dominant, the other also plays a role. With the spectral domain enlarged to the UV and the IR, there appear to be diagnostic lines that are more informative than those in the optical range. For example, the coronal lines in the IR from highly ionized species are hard to produce by shocks, while certain UV lines are difficult to understand by photoionization models.

Are the Gigahertz peaked spectra due to synchrotron self-absorption or to free–free absorption? Either of the two can be made to fit, if inhomogeneous media are admitted. Perhaps variability in rotation measures, in X-ray absorption and in spectral shape may be correlated to give further evidence about the free–free absorption, if enough VLBI polarisation observations can be obtained.

And last of all, *are radio galaxies the same as radio quasars differing only in aspect as proposed in the unified models?* Apparent differences have been noted but, especially in the CSO, selection effects may also play a role. I would guess that unification is largely correct, but that it is somewhat modified by various effects. As an example, in Seyfert galaxies if star formation occurs and inflates the absorbing layer, it is no surprise that in a sample of Sy 2 galaxies there is higher frequency of star formation even though the basic premises of unification remain valid. With radio galaxies comprising broad line, narrow line and lineless objects, and with quasar properties also far from uniform, it should not be surprising that especially in the compact objects some differences between radio galaxies and quasars may be found.

Turning to the future, we may expect by the time of the next meeting much progress in some areas. X-ray

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observations with XMM and Chandra should tell us about the central source, its immediate environment and the medium into which the doubles expand. High-resolution VLBI radio data on expanding sources, their nuclei, linear and circular polarisation, Faraday effects and H I absorption will further refine the picture. Additional samples of radio sources should inform us about their volume densities and evolution. And finally, optical and IR spectral data are still needed to further ascertain the excitation and dynamics of the gaseous surroundings. Five years from now there should be ample justification for another meeting, hopefully in Kerastari or in a place equally nice.