ELECTRON ENERGY DISTRIBUTIONS OF AGNS IN THE THIN SYNCHROTRON LIMIT. I. THE METHOD

LUIS SALAS, IRENE CRUZ-GONZÁLEZ and LUIS CARRASCO
Instituto de Astronomía UNAM, Apdo 70-264 Mexico DF 04510, Mexico

Abstract. We develop a new method called "Inverse Synchrotron Transform" (IST) to study the spectral energy distributions of AGNs. We demonstrate that it is possible to use Bayes Theorem for conditional probabilities to derive a self-consistent solution for the electron energy distribution (EEDs), starting from the observed spectral energy distributions (SEDs) and the assumption that the only physical process involved is thin synchrotron radiation. We test the IST method and find that it allows to distinguish among different EEDs that produce SEDs which nevertheless seem very similar. We apply the method to multifrequency simultaneous observations of AGNs (paper II, this conference).

Key words: active galactic nuclei, multiwavelength emission, emission processes

1. Results

Synchrotron emission has been associated with the non-thermal component in most extragalactic sources due to the observed polarization degree and power-law spectral characteristic. There is agreement that in the most violent sources the dominant component is non-thermal. The continuum distributions for the later sources were interpreted as due to synchrotron and synchrotron self-Compton components [3, 4]. In all these models it is assumed that the EED is a power-law. A power-law EED ($N(E) \propto E^{-p}$), is a convenient form since it represents a solution of the continuity equation under steady state conditions. However, there is now increasing evidence that there is no regularity in the high variability of some AGNs, suggesting one to explore non-stationary solutions for the continuity equation.

We propose to abandon the a priori assumption that N(E) is necessarily a power-law, relaxing completely the assumption of any particular form for $N(E)$. Instead, we calculate the most probable $N(E)$ which is consistent with the observed spectra. The spectrum of the emitted radiation by a thin synchrotron source $W(\nu)$, can be written as an integral transform from a space that is a combination of electron's energy and magnetic field (electron's critical frequency $\nu_c \propto B\gamma^2$), to radiation's frequency space, $W(\nu) = \int_0^\infty P_s(\nu, \nu_c)\Psi(\nu_c)\, d\nu_c$. The Kernel of this integral transform is normalized in such way that it can be interpreted as a conditional probability. This allows the use of Bayessian inference techniques to invert this equation through the Richardson-Lucy algorithm [5, 2] in a way analogous to the implementation given by Salas [6] for thermal radiation. Tests of the method with sets of artificial data, allow to distinguish between different EEDs, such as power-laws and superposition of delta functions, that produce similar spectral energy distributions, even when the input is moderately noisy.

T. J.-L. Courvoisier and A. Blecha: Multi-Wavelength Continuum Emission of AGN, 358–359.

References

1. Blumenthal,G.R., Gould,R.J., 1970, *Rev. Mod. Phys.* **42**, 237.
2. Lucy,L.B., 1974, Astronomical Journal**79**, 745.
3. Jones,T.W., O'Dell,S.L., Stein,W.A., 1974, Astrophysical Journal**188**, 353.
4. Jones,T.W., O'Dell,S.L., Stein,W.A., 1974, Astrophysical Journal**192**, 261.
5. Richardson,W.H., 1972, *J. Opt. Soc. Am.* **62**,55.
6. Salas,L., 1992, Astrophysical Journal, **385**, 288