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Measuring Angular Diameters of Planetary Nebulae

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Abstract. We have analysed about 350 Hα CCD images of PNe in order to measure their angular diameters. 3 different methods were used for calculations. Results and comments on each method are presented.

1. Analysis of the data

To determine angular diameters one can use several methods. One of them is a direct measurement of the nebular extension up to an assumed value (usually 10%) of surface brightness. Another method is a Gaussian deconvolution, which is based on the full width at half maximum (FWHM) of a 2-dimensional Gaussian fitted to the observed surface brightness distribution in a least-squares sense. A certain modification of this method is a second-moment deconvolution. In this case the second moment of surface brightness distribution is used to calculate FWHM. Other techniques base on measuring the maximum extent of the emission.

The details of the deconvolution methods used can be found in van Hoof (2000). Two extreme cases of a spherically symmetric model nebula in the deconvolution process were used: sphere of uniform density and constant emissivity shell with inner radius equal to outer radius. Other shell models with an arbitrary inner radius give results situated between these 2 cases.

Hα CCD images were taken from catalogues of Schwarz, Corradi, & Melnick (1992) and Górny et al. (1999).

The figures show results of the analysis. $\theta_{10\%}$, θ_{Gauss} and θ_{s-m} indicate the diameters derived from direct measurements, the Gaussian deconvolution and the second-moment deconvolution, respectively. Parameters β_{Gauss} and β_{s-m} describe the ratio of the Gaussian diameter to the beamsize derived from Gaussian and second-moment deconvolution, respectively. The diameters are in arcsec.

2. Conclusions

Systematic differences in the results of different methods can be seen. Diameters derived from the direct measurement are larger than those calculated from the deconvolution methods. Differences depend on the model of nebula being used: the thinner shell is, the bigger is the difference.

Direct measurements are good for nebulae with well-defined outer radius. Observations should be of good resolution and quality. No assumptions about

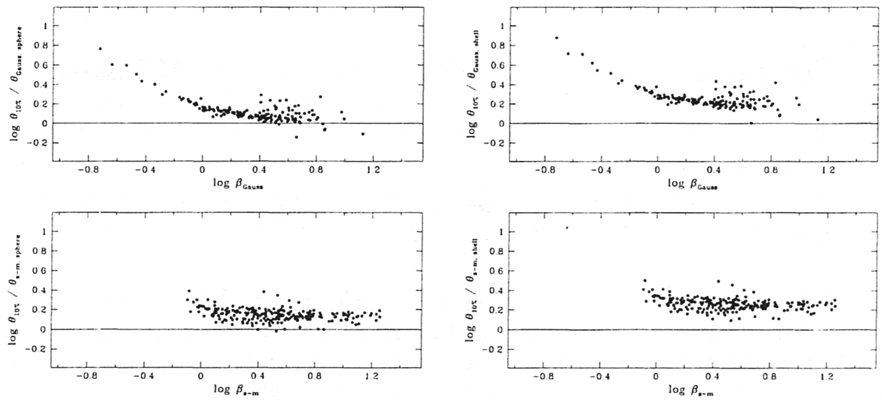

Figure 1. The $\theta_{10\%}$ to θ_{Gauss} ratio versus β_{Gauss} (2 upper figures) and the $\theta_{10\%}$ to θ_{s-m} ratio versus β_{s-m} (2 lower figures) for two models of PN. Solid line: 1:1 relation for calculated diameters.

the intrinsic surface brightness distribution have to be made. This method is not recommended for measuring diameters of compact nebulae, in which seeing is comparable with the diameter of the source. To obtain a reliable angular diameter of a planetary nebula it is required that the measured diameter is at least 3 times greater than the seeing.

Deconvolution methods can be used to measure diameters of partially resolved sources. The second-moment deconvolution method seems to be unable to measure diameters of nebulae smaller than the seeing.

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