What PNe could tell about extinction inside external galaxies

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Abstract. With the extinctions measured in PNe of the Galactic Bulge we had verified that the classical small clouds model for extinction in the solar neighbourhood is easily generalized to the entire Galaxy. I use this model to explore the behaviour of extinctions of PNe observed in an external galaxy. With a resonable number one can derive the opacity of the extinction disk. A larger number would be required to constrain the ratio of the scale heights of PNe and extinction. The measurement of the $H\alpha/H\beta$ ratio of PNs in disk galaxies provides a most useful probe to learn about the interstellar medium in external galaxies.

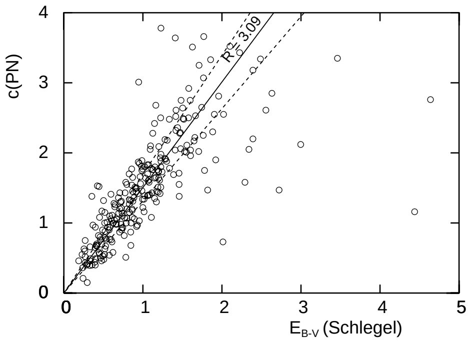

Fig. 1. The extinctions c measured in 271 Galactic Bulge PNe compared to the reddening at their position estimated from the map of Schlegel et al. (1998)

The extinctions measured in planetary nebulae of the Galactic Bulge show a systematic decrease with the nebula's galactic latitude. This relation is well reproduced with an extension of the classical statistical model of Galactic extinction, which assumes that small clouds of equal extinction are randomly distributed in a thin exponential disk (Köppen & Vergely, 1998). The observed extinctions also compare well with the extinctions one obtains from the map of Schlegel et al. (1998) for the positions of each nebula. Not only the average relation is as expected, but also the scatter agrees with the Poissonian model.

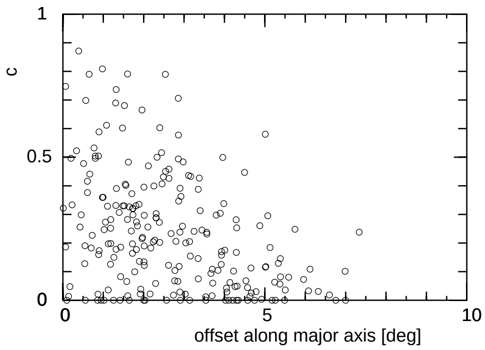

Fig. 2. The expected extinctions of PNe in the disk of an external galaxy as a function of offset along the major axis (10^o correspond to 15.7 kpc)

What would one observe, if one could look from the outside at the population of Galactic disk PNe? We assume an inclination of 27^o and an observer's distance of 89 kpc. The PNe are distributed in an exponential disk of radial scale of 3 kpc and a scale height of 250 pc. If one selects PNe in a 2^o wide strip along the major axis, the model predicts the relation between the extinction measure c and the offset from the galactic centre, shown in Fig. 2. At each position there is a range of extinctions possible, as one samples the nebulae in front of the dust disk (low extinction) to those behind (high extinction). The range decreases in the outer zones of the galaxy. Most objects are in the galactic plane, hence they are found as a ridge of slightly enhanced density in the middle of the triangular-shaped distribution. The upper envelope of the objects in the plot yields the the opacity of the galaxy, i.e. the average opacity of the clouds and the number density of the clouds with respect to the gas density. The simulations show that this can be achieved with less than about 300 objects.

Information on the relative distribution of planetary nebulae and dust is contained in the details of the distribution of objects: The larger the PN scale height is in comparison with that of the dust disk, the more evenly are the objects spread out in the diagram. However, the simulations show that one needs a rather large number of objects to reliably extract this interesting information about the PN population in that galaxy.

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References

1. J. Köppen, J.-L.Vergely: MNRAS **299**, 567 (1998)
2. D.J.Schlegel, D.P.Finkbeiner, M.Davis: ApJ **500**, 525 (1998)