DUST EFFECTS ON KINEMATIC MODELS OF ELLIPTICALS

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Abstract. The majority of elliptical galaxies is believed to contain interstellar dust, particularly in the innermost regions. We have investigated the effects of a diffuse dust component on the observed kinematics of spherical galaxies, and modelled dusty observables as if no dust were present. We find that the total mass and the orbital structure of the best fitting models differ considerably from the input models, primarily due to the changes in the observed light profile. We argue that dust should therefore be taken into account in the modelling procedure.

1. Introduction

It has become well-established that the presence of dust in ellipticals is the rule rather than the exception. Since dust masses derived from IRAS far-infrared data are roughly an order of magnitude higher than those determined from optical extinction data, a major part of the dust is believed to be in the form of a smooth component (Goudfrooij and de Jong, 1995). It has been demonstrated that a diffuse dust distribution can have considerable effects on the photometry (Witt, Thronson and Capuano, 1992; Wise and Silva, 1996).

In stellar dynamics modelling however, dust has not yet been taken into account. Nevertheless, dust absorption affects the projection of every moment of the phase-space distribution function: instead of a simple integration along the line-of-sight one obtains a weighted integration, as dictated by the equation of radiative transfer. Therefore, not only the light density will be affected, but also the observed kinematics, e.g. the projected dispersion profile.

2. The Modelling

First we investigated the effects of a smooth dust distribution on the observed kinematics of ellipticals, using a series of analytical models for dusty spherical galaxies (Baes and Dejonghe, 2000). The effects on the light profile are straightforward: dust causes an overall reduction of the amount of starlight that reaches the observer. Even for modest optical depths the light profile can be affected by up

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to 50%. The effects on the projected velocity dispersion or on the LOSVDs have a different nature. There is no overall reduction, just a redistribution: dust makes the contribution of the nearer parts of the lines-of-sight more important, relative to the further parts. Quantitatively the effects are rather small, roughly 1% per optical depth unit for the central projected dispersion. They become thus only important for larger amounts of dust.

We generated sets of synthetic LOSVD data for a series of spherical galaxy models with modest amounts of dust. These data were used as input for a Quadratic Programming modelling procedure (Dejonghe, 1989), in which the dust is not taken into account. A best-fitting distribution function is constructed as a linear combination of simple analytical dynamical components. For all our models, the fits are excellent. Comparing the input and output models we investigate the effects of not taking dust into account in kinematic modelling procedures. We find that they differ significantly. First, the best fitting total mass decreases when the optical depth increases, typically 5% per optical depth unit. Moreover, the orbital structure of the galaxy is altered: dust tends to make the galaxies more radially anisotropic in the outer regions.

3. Conclusion

We investigated the possible artifacts that can appear when modelling dust-affected kinematic profiles without taking the dust into account. Although only the light profile is at first glance seriously affected and the LOSVDs are nearly invariable, the mass and orbital structure of the input and output models differ significantly. We stress that the determination of the dynamical mass and the kinematic structure of galaxies is not only determined by the observed line-of-sight velocity structure, but is also dependent on the observed light profile. Since this profile is severely affected by dust obscuration, we can conclude that dust should be taken into account when making kinematic models.

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