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INTERNAL EXTINCTION IN SPIRAL GALAXIES. INCLINATION DEPENDENCE

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ABSTRACT. Kent (1986) finds that the surface brightness profiles $\sigma(r)$ of spiral galaxies have a weak dependence, if any, on the inclination θ with respect to the line of sight. This author also finds a correlation between the M/L ratio and the inclination of a galaxy. The lack of dependence of $\sigma(r)$ in $\mu = \cos\theta$ indicates that the disk of these galaxies is optically thick ($\tau>1$), due to the presence of dust grains. For an optically thick system $\sigma(r) = \sigma_0 + 2.5 \log\mu$.

The cosecant law $A_\lambda = 1.086\ \tau_\lambda$ (Holmberg, 1975) does not explain the observed behaviour of $\sigma(r)$ with μ. Bruzual, Magris and Calvet (1986) solved the radiative transfer equation for a mixture of stars and dispersive dust grains distributed homogeneously in a plane parallel configuration, taking into account the wavelenght dependence of the albedo and τ, as well as the redistribution in angle of photons scattered by dust grains. The transfer equation is solved for the dimensionless intensity $\xi(\tau,\mu) \equiv I(\tau,\mu)/I^*$, where I^* is the intensity emerging from the dust free configuration. The solution, $C_\lambda \equiv -2.5 \log \xi(\tau=0,\mu)$, includes the correction to the galaxy magnitude due to the excess number of stellar sources along the line of sigth ($\propto \mu^{-1}$) with respect to the μ=1 case (face on galaxy). For optically thick systems, C_λ does not depend on μ.

The luminosity of a disk galaxy observed with inclination μ is given in our model by $L \propto \mu\xi$, from which $\log(M/L) = \text{const} + 0.4\ G_\lambda(\mu)$, with $G_\lambda(\mu) \equiv -2.5 \log(\mu\xi)$. The constant is determined from the mass-luminosity ratio of a dust free system. In terms of the correction $G(\lambda)$ we can explain Kent's observations with values of τ^0_V between 0.3 and 4. These values are consistent with the observation of μ-independent surface brightness profiles mentioned above.

From this analysis we conclude that the correction terms of Bruzual, Magris and Calvet (1986), which take into account the dispersive properties of interstellar dust, can explain the behaviour of $\sigma(r)$ and M/L with galaxy inclination. These correction terms predict corrections to surface brightness and colors very different those predicted by the cosecant law. These terms should be preferred over the standard law to derive the photometric properties of dusty galaxies.

Key words: GALAXIES-SPIRAL — INTERSTELLAR-EXTINCTION

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