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Superposition method of constructing parametric models of luminosity distribution in galaxies

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Kuzmin's superposition method (Kuzmin 1966) is applied for constructing luminosity space distribution in galaxies. Description functions of a model are taken in analytical form with free parameters. An interstellar light absorption is taken into account. The present work continues an earlier investigation (Kutuzov & Mardanova 2004).

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1 Method

We describe a partial subsystem by a certain analytical function of a position vector $\mathbf{r}$ i.e. $f(\mathbf{r}\,|\,\mathbf{c},\mathbf{p})$ with given form and including two sets of free parameters, namely $\mathbf{c} = (c_1, \ldots, c_k)$ and $\mathbf{p} = (p_1, \ldots, p_m)$. The first set is common for all components of the final model and does not change during a superposition. The total descriptive function is defined as weighted mean of the all partial functions by integrating over the second set of parameters keeping $\mathbf{r}$ fixed:

$$\overline{f}(\mathbf{r}\,|\,\mathbf{c},\,\mathbf{d}) = \int\limits_{\mathcal{P}} .. \int w(\mathbf{p}\,|\,\mathbf{d})\, f(\mathbf{r}\,|\,\mathbf{c},\,\mathbf{p})\, d^m\,\mathbf{p}, \quad \int\limits_{\mathcal{P}} .. \int w(\mathbf{p}\,|\,\mathbf{d})\, d^m\,\mathbf{p} = 1. \qquad (1)$$

Here $w(\mathbf{p}\,|\mathbf{d})$ is an integrable normalized weight function which includes a set of its own parameters $\mathbf{d} = (d_1, \ldots, d_l)$. $\mathcal{P}$ denotes an allowable domain in the space of parameters $\mathbf{p}$. So a superposition is realized by means of parameters $\mathbf{p}$. If the parameters $p_j,\ j = \overline{1,\,m}$ are mutually independent we can take the weight function in the form of a product

$$w(\mathbf{p}\,|\,\mathbf{d}) = \prod_{j=1}^{m} w_j(p_j\,|\,d_j). \qquad (2)$$

We use a luminosity density $\mathcal{E}$ generated by stars as a main description function here. Note that it is additive one.

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2 Model

We assume a partial luminosity density as a function of cylindrical coordinates $R,\ z$

$$\mathcal{E}(R,\ z\,|\,\varepsilon,\ h) = \mathcal{E}_0 \exp(-a/h)\,, \qquad a^2 = R^2 + z^2/\varepsilon^2\,. \tag{3}$$

It describes a spheroidal luminosity distribution with sphericity $p_1 = \varepsilon \in [0,\ 1]$ and length parameter $p_2 = h \in (0,\ H]$. A coefficient $c_1 = \mathcal{E}_0$ is a common scale parameter. The weight function is taken in the form (2) where $w_1(\varepsilon\,|\,\alpha_1\,,\delta_1)$ and $w_2(h\,|\,\alpha_2\,,\delta_2)$ are given. Integrating the partial luminosity density according to Eq. (1) we obtain a total luminosity density $\overline{\mathcal{E}}(R,\ z\,|\,\mathcal{E}_0,\ \alpha_1,\ \delta_1,\ \alpha_2,\ \delta_2,\ H)$. Obviously the total luminosity distribution is not spheroidal one.

In an analogous way we superpose dust unhomogeneous spheroids with various spheri- cities κ. An absorption coefficient is taken to be proportional to the total dust density. Light scattering is neglected.

Finally we integrate the total luminosity density along a line of sight taking absorption into account and obtain projected brightness of galaxy image. It depends on the parameters $\mathcal{E}_0, \alpha_1,\ \delta_1,\ \alpha_2,\ \delta_2,\ H,\ i$ which can be estimated. Here i is an inclination of line of sight to rotation axis of galaxy.

3 Some results

A great number of calculations were fulfilled for various set of parameter values. Some graphics of brightness isophotes are drawn. An influence of light absorption is investigated.

Here a direct problem is solved i.e. luminosity space distribution is given and brightness surface distribution is found. We plan to continue this work and intend to estimate brightness parameters for some real galaxies. Then an inverse problem will be solved.

References

G.G. Kuzmin, Tartu Astrophys. Observ. Publications. **35** 285 (1966).
S.A. Kutuzov, M.A. Mardanova, Proc. Sternberg SAI. **75** 109 (2004).