Declining rotation curves in interacting galaxies

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Introduction

A declining rotation curve was recently found for the galaxy NGC 3521 by HI synthesis telescope observations (Casertano and van Gorkom 1991). From a comparison of the shapes of rotation curves for a larger sample of galaxies Casertano and van Gorkom argue that this is due to initial properties during the phase of galaxy formation.

In several studies of global properties of galaxies, NGC 3521 was always considered a "normal" unbarred, non-interacting, isolated spiral. However, here we present CCD surface photometry that shows at low surface brightness levels the typical signs of interaction or even merging.

Observations and reduction

A TI 800×800 chip with 15μm pixels was used with the 20 cm–aperture Takahashi ϵ200 telescope ("BBST", Gallagher et al. 1991) which is mounted on the side of the Lowell Observatory 1.1 m Hall-telescope. This set-up has a 51′ field of view at an image scale of 3.88″ /pixel. The Observations reported here were obtained with a broad band R filter.

Several Takahashi images were aligned and scaled as a function of exposure time. A plane was fitted to the sky background. The saturated inner parts of the long exposures were replaced by the short-exposure images.

Absolute calibration by simulated aperture-photometry was performed using photoelectric BVR measurements collected from the literature. The R-band calibration used here depends on a single aperture measure obtained in Kron-Cousin R at MSSSO.

Results

In Fig. 1 we present a contour plot of the surface brightness distribution in a 22 arcmin field for the calibrated R band data. This should be compared with the plates at different contrast settings given by Sandage and Bedke (1985).

Outside of the inner 5 arcmin NGC 3521 shows a pronounced asymmetry. In the north-west we can trace the galaxy out to ∼10 arcmin, while it ends at ∼6 arcmin in the south-east. At the fainter levels the spiral structure is disturbed too. A spiral spur connects the regular spiral arm in the north-west with the faint extended envelope. This spiral feature can be traced out to r=8 arcmin from the nucleus. The outer parts to the south-east are much brighter without any sign of sub-structure. The contour plot given shows a change in the slope of the brightness distribution at r=5 arcmin on the major axis. For r>5 arcmin the contours near the major axis become much wider spaced, indicating a larger scale length for the brightness distribution, and this outer disk also has a box-like structure. In the south-east this structure drops off in intensity very suddenly at r=6.5 arcmin, producing a sharp edge or shell with an opening angle of ∼15° at a position angle of PA=173°. The fainter but more extended northern part has an opening angle of 20° at a position angle of PA=175° with a brighter condensation at r=9 arcmin at PA=178°. The faint extensions are slightly twisted with respect to the inner disk which is at PA=168°.

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Conclusions

With the evidence for a recent interacting event for NGC 3521 presented here, the declining rotation curve is best explained in an evolutionary scenario in which "soft" merging or interaction plays an important rôle. It it noteworthy that the spiral pattern of this galaxy is well behaved while the outer disk is heavily disturbed.

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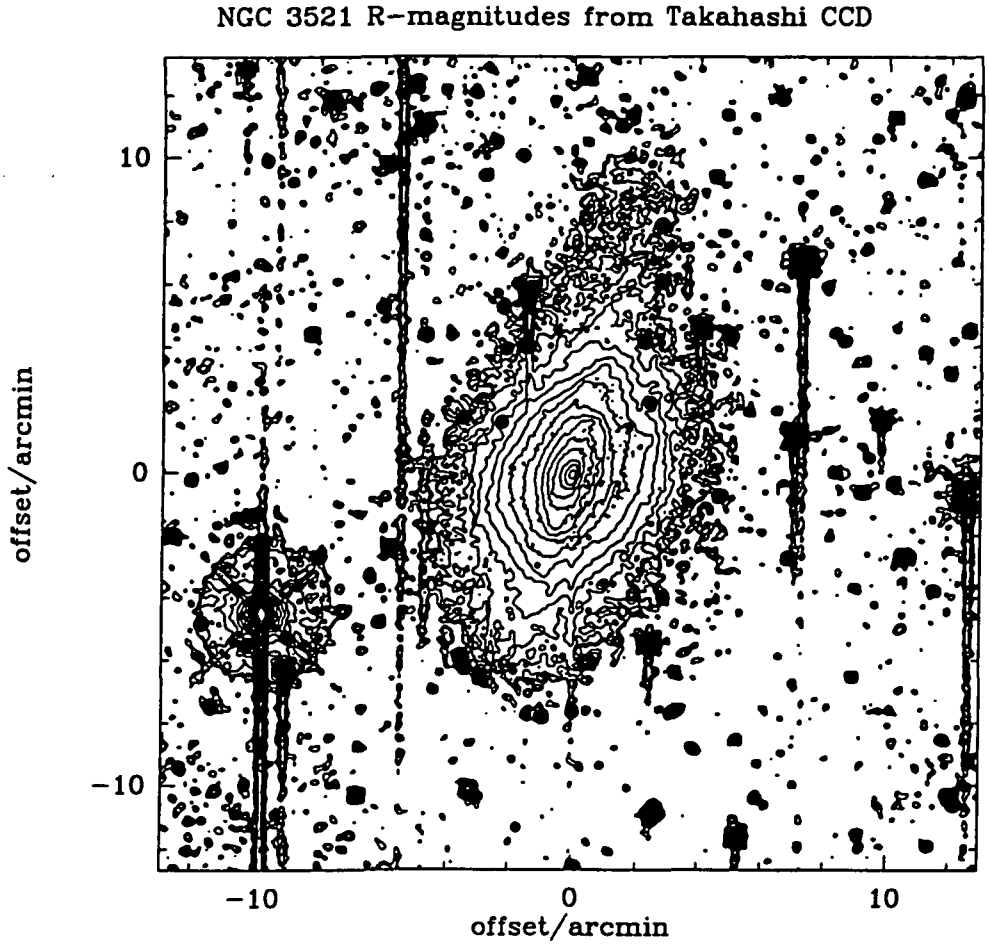

Figure 1: Contour plot of surface brightness distribution of NGC 3521 in the R band from Takahashi CCD photometry. The lowest contour is at μ_R=25.5. the step between contours is $\Delta\mu_R$=0.5.

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