rich nuclear galaxy spectrum. The burst duration, implicit in these simulations, is that of a single generation star cluster, hence, amongst the shortest. Consequently, we could explore in this work only the dependences on the burst strength and age. For illustration, we provide in Figure 4 the early evolutionary stages from 5 to 50 Myr, of the composite spectrum. Notice the rapid spectral changes. The dependence on the burst strength is shown in Figure 5a and b, in terms of absolute luminosity increase and colour evolution of the composite light: the stronger the burst, the longer its impact on the composite system, as expected.

We are not aware that any starburst galaxy has been detected so far with TiO bands as strong as those observed in the LMC blue clusters passing through the M supergiant phase. This suggests that starbursts in galaxies are not time-peaked but rather made of multiple, successive stellar generations. Then, the absence of the M supergiant molecular signature could be understood as the result of dilution effects: the contribution from evolutionary stages outside the 7 to 12 Myr, which are free of molecular absorption, will wash out the molecular bands from the short-living M supergiant phase at 10 Myr. A weak metallicity in the starburst could contribute also to a weakening of the molecular bands. The M supergiant phase in a metal-rich composite population could be prominent only if the burst duration were quite short and the burst age were around 10 Myr. In contrast, the near IR CaII triplet should be a conspicuous feature in most starbursts, because it is present at all evolutionary stages from 6 to 500 Myr (Fig. 2).

We are now in the process of simulating starbursts in low-metallicity galaxies such as dwarf galaxies. In parallel, we are performing direct population synthesis of a sample of 60 dwarf blue and red galaxies.

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The Planetary Nebula NGC 3132: a Three-Dimensional Ionization Model

M. BÄSSGEN, C. DIESCH, M. GREWING, Astronomisches Institut, Tübingen, Germany

1. Introduction

Planetary Nebulae (PNe) are an intermediate stage in the stellar evolution from a red giant star to a white dwarf of stars with masses between 1 $M_\odot$ and about 8 $M_\odot$. Most of the light emitted from PNe consists of emission lines from ions excited by the UV radiation of the hot central star. As the PN consists of material ejected from the red giant star during the AGB Phase, investigations of the morphology and the dynamics of PNe can give information about the mechanisms that cause the mass loss from the red giant star.

The major problem investigating the morphology of PNe is the fact that there is no simple way to get the three-dimensional density distribution in the nebulae. As PNe are optically thin in the light of emission lines, two-dimensional images show the integrated flux emitted from all locations in the line of sight into the direction to the observer. Thus there are several three-dimensional density distributions leading to the same monochromatic image. But most PNe show strong evidence that a spherically symmetric density distribution cannot match with the monochromatic images. Statistical methods lead to systems assuming several PN morphologies representing different evolutionary stages in some morphological classes (Balick, 1987), in which a lot of PNe seem to fit in easily, but it is difficult to justify whether a single PN really shows a specific morphology or not.

One possibility to check at least the consistency of a given density distribution for a single PN is to compare images taken from that PN in the light of different ionization stages of several elements with artificial images calculated with three-dimensional ionization models. Assuming a given density distribution, it is possible to calculate the ionization equilibrium at each location, depending on the temperature, the UV flux from the central star and monochromatic images, that can be compared to observed monochromatic images.

The observational methods for PNe made a big progress in the last years. With the availability of sensitive CCD detectors combined with narrow interference filters it is easily possible to obtain monochromatic images of PNe with high spatial resolution. At La Silla this can be done e.g. with the 2.2-m telescope. Even images in the weak lines like OIII 463.3 nm and sometimes HeII 4686 can be obtained in most cases with exposure times less then 30 minutes. The extended old PNe can at least be imaged in the bright lines like OIII 500.7 nm and NII 658.4 nm. With the B&C spectrographs of the 2.2-m and 1.52-m telescopes combined with CCD detectors it is possible to get spectra of different positions inside the PN. With the 22.4 nm/mm grating at the 1.52-m telescope (15 μm high resolution CCD) we obtained spectra (each in the range from about 400 nm–700 nm) with exposure times between 1 and 30 minutes. The spectral resolution of this grating is sufficient to separate the important emission lines we need for comparison with our model calculations. So the observational presuppositions are given to improve the old spherically symmetric model calculations.

2. Observations

The spectroscopic observations used in this article were performed in February 1989 at the 1.52-m telescope in combination with a Boller & Chivens spectrograph equipped with a CCD detector (pixel size = 15 μm). The slit width was chosen as 2″. The resolution of the grating was 22.4 nm/mm (0.34 nm/pix). We obtained long-slit spectra from two positions south and two positions north of the centre of NGC 3132. The slit orientation was east-west. Knowing the exact position of the spectrograph slit and knowing the total Hβ emission of the object, it is possible to absolutely calibrate the measured Hβ flux. With this local calibration at Hβ and using the also observed energy distribution of spectrophotometric standard stars, it is possible to calibrate the spectra throughout the entire range from 400 nm to about 700 nm.

The direct monochromatic images were obtained in April 1988 with the 2.2-m ESO/MPI telescope equipped with a CCD detector (pixel size = 30 μm). The images were reduced using standard MIDAS reduction procedures.

3. Model Description

Our model consists of a cartesian cube which contains about 30,000 subcubes V_{ijk}, with i,j,k ranging from −15 to +15. A local density is assigned to each volume element. The central star is positioned in the centre of the cube at (0,0,0). In all volume elements the ionization and thermal equilibrium is calculated. The absorption on the way from the central star to the volume element is taken into account. For these calculations a CONVEX vector computer of the University of Tübingen is used. A more detailed description of our model is given in Bässgen, Diesch and Grewing (1990).

One problem is to "fill" our cube with a density distribution of a real nebula. To do this for NGC 3132 we fitted an ellipsoidal shell with density n_1 which surrounds an ellipsoid with a very small density n_2 to observed Hβ-images. The exact procedure is described in Bässgen et. al (1990), too.

To obtain an idea about the three-dimensional distribution of an object, high resolution spectroscopy (e.g. CAT observations) plays an important role.

4. Results

Due to the cube structure of our model it is easily possible to calculate emission line fluxes of distinct regions of the object and to construct artificial monochromatic images. Figure 1 shows the reduced observed and the calculated spectrum of the position 8″ south of the central star. We chose a logarithmic ordinate to make the weaker lines visible. Figure 2a–2d show observed and calculated OIII 500.7 nm and NII 6584 images.

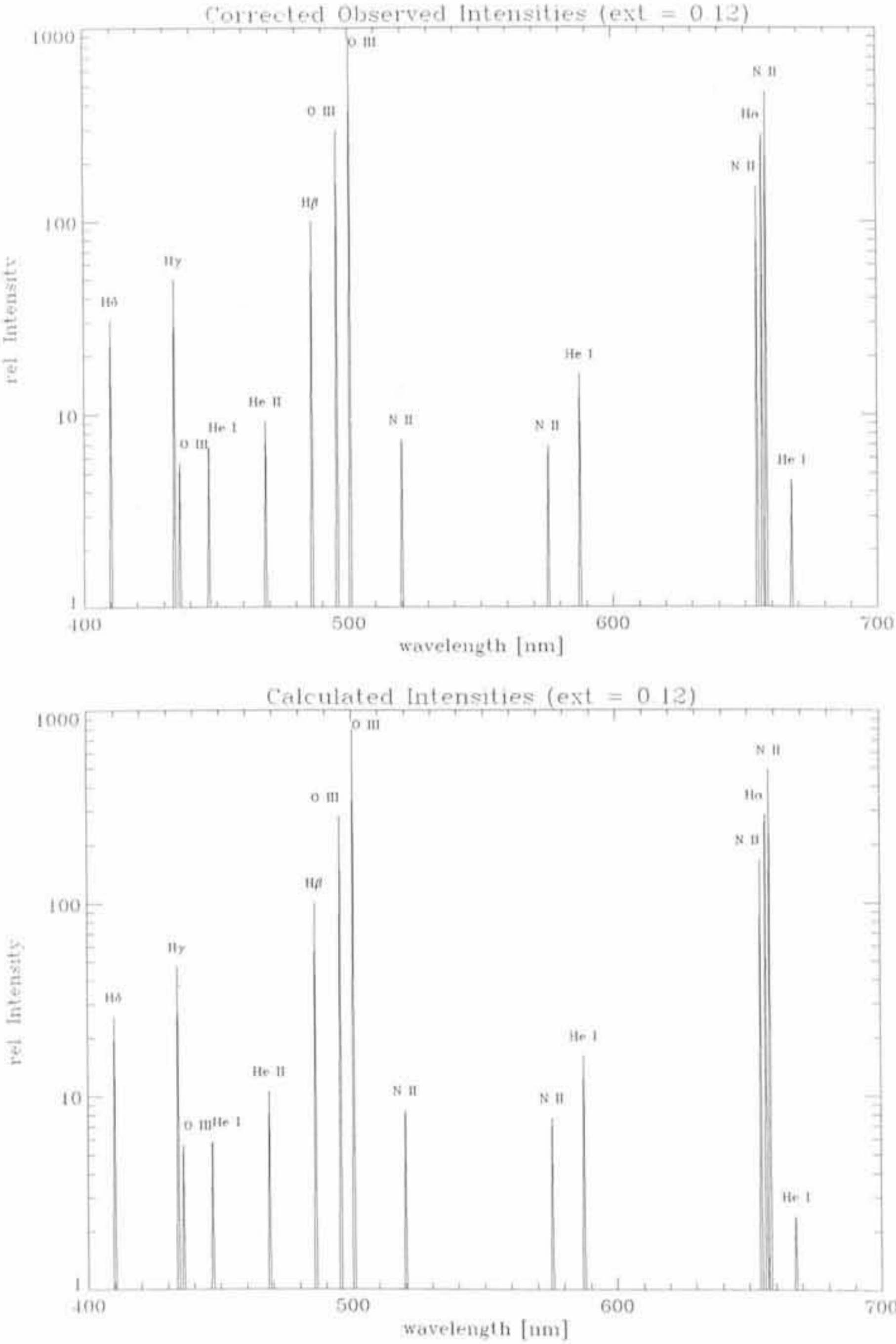

Figure 1: *Comparison of calculated and observed emission line fluxes at the position 8″ south of the central star.*

5. Conclusions and Future Work

With our new computer code we can leave spherical symmetry in modelling PNe. It is an adequate instrument to explain the spatially resolved monochromatic images and spectra available with modern sensitive detectors.

We plan to continue our work into two directions.

(a) We started to make two-dimensional cylindrical symmetric ionization models with a very high spatial resolution (= pixel size of CCD images) so that we can use CCD Hβ images directly as input density distributions after some geometrical transformations.

(b) Three-dimensional models as described above, but with a more accurate treatment of the radiation transfer. The problem is the increasing computer time. With this kind of models it would probably be possible to explain the low ionization filaments in PNe which might

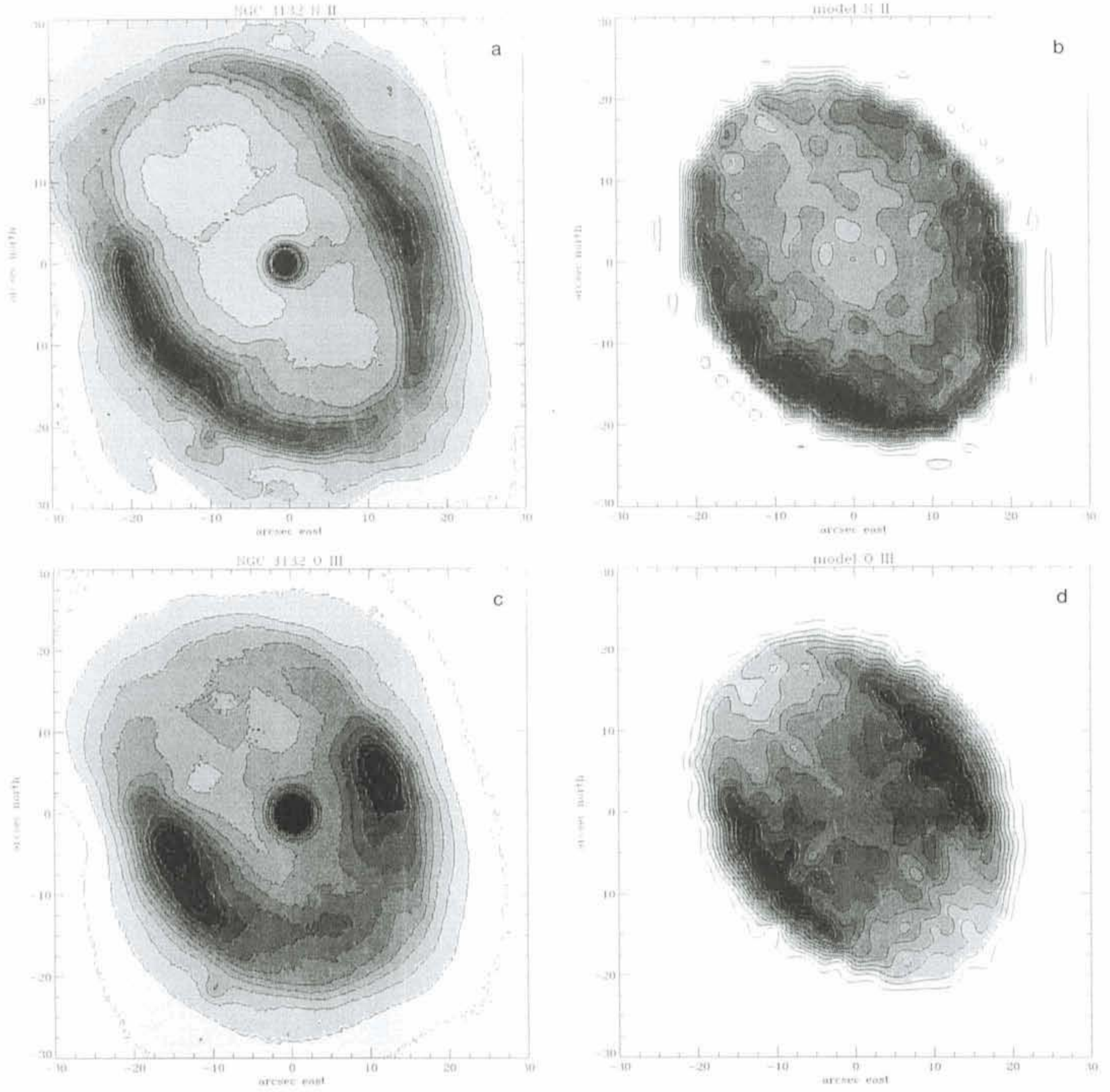

Figure 2 a–d: *Observed and calculated monochromatic OIII and NII images. The calculated images have been extended to a higher pixel number to allow direct comparison.*

be caused be shadowing effects combined with ionization by diffuse radiation of the neighbouring volume elements. It would also be possible to study the ionization structure of knots and so-called ansae. With the improved observing possibilities those features seem to be common in a lot of PNe.

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Peculiar Kinematics in Interacting Elliptical Galaxies

R. MADEJSKY, Landessternwarte Heidelberg, Germany

Introduction

The investigation of galaxy encounters is important to understand the dynamical processes of tidal interaction between galaxies and to probe the internal dynamics of galaxies. Encounters between galaxies are not extremely rare and they cannot be neglected in the evolution of galaxies because even one efficient encounter may substantially alter their internal structures. Efficient interaction can lead to merging of galaxies.

Interactions between galaxies in the