Radial population synthesis and the ionization of gas in elliptical galaxies

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Introduction

A remarkable discovery of recent years has been the detection of various kinds of interstellar matter (ISM) in elliptical galaxies. The presence of dust patches, ionized gas, and hot X-ray gas have proven to be quite common in ellipticals which were once thought to be simple structures, devoid of gas and dust. A review of ISM in ellipticals has recently been published by Forbes (1991). However, the origin and fate of ISM in ellipticals is not fully understood. Its origin may be stellar mass-loss, condensation of hot X-ray gas pervading the galaxy, or merging with gas-rich galaxies. Recently, the merger picture receives much attention, since (i) the ionized gas usually is dynamically decoupled from the stars, and (ii) the great variety in radial line-strength gradients found among ellipticals also favours merging as formation process (cf. Gorgas et al. 1990). To study the origin and fate of ISM in ellipticals we are currently undertaking an optical survey of a complete sample of ellipticals ($B_T^0 < 12$, cf. Goudfrooij et al. 1990). An important result of our extensive CCD imaging program is that a relevant fraction of the sample objects exhibits dust patches within Hα+[NII] line-emitting filaments. This common occurrence can be easily accounted for if the dust and gas have an external origin. In these cases, the extended line emission often has a peculiar distribution and is more sharply peaked at the nucleus than is the stellar continuum. Furthermore, all of these ellipticals exhibit a compact flat-spectrum radio source in their nucleus, suggesting that this nuclear activity also has an external origin. In this respect it would be interesting to know the excitation mechanism of the gas.

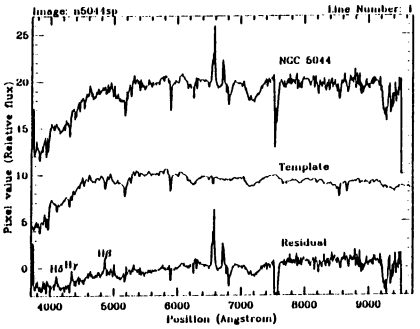

Fig. 1. *Nuclear spectrum of NGC 5044, its best-fitting template, and its residual pure emission spectrum. Notice the dramatic change in e.g. the Balmer line intensities. A suitable constant was subtracted from the template for visualisation*

Studying the Excitation Mechanism using Population Synthesis

Competing possibilities for the gas in ellipticals are shocks, photoionization by either an active nucleus, hot stars within the filaments, or coronal X-ray photons, and ionization by hot electrons in the coronal plasma. A major difficulty in deciding which mechanism is at work is the fact that the emission-line spectrum is superposed on a strong-lined stellar population, making the detection of e.g. faint Balmer line-emission a hard task. However, the use of a population synthesis program based on star cluster spectra[1] proves to be a powerful method to overcome this problem. In Fig. 1 a spectrum of the nucleus of the merger candidate NGC 5044 (cf. Goudfrooij 1991) is shown together with its best-fitting template, and the resulting pure emission spectrum. More information on the synthesis program can be found in van den Hoek & Goudfrooij (this conference). A major advantage of this method is the ability the trace radial changes in line intensity ratios while performing the radial population synthesis, probably leading to important clues concerning the excitation of gas in ellipticals. A more thorough account of this study will follow in due course.

References

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[1] We gratefully acknowledge the ability to use the synthesis program written by E. Bica (e.g. 1988, A&A, 195. 76)