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New Astronomy Reviews 49 (2006) 613–617
New Astronomy Reviews
www.elsevier.com/locate/newastrev

Integral field spectroscopy with GEMINI: Extragalactic star cluster in NGC1275 ☆

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Available online 15 November 2005

Abstract

Studies of globular cluster systems play a critical role in our understanding of galaxy formation. Imaging with the Hubble Space Telescope has revealed that young star clusters are formed copiously in galaxy mergers, strengthening theories in which giant elliptical galaxies are formed by the merger of spirals [e.g. Whitmore, B.C., Schweizer, F., Leitherer, C., Borne, K., Robert, C., 1993. Astronomical Journal. 106, 1354; Miller, B.W., Whitmore, B.C., Schweizer, F., Fall, S.M., 1997. Astronomical Journal. 114, 2381; Zepf, S.E., Ashman, K.M., English, J., Freeman, K.C., Sharples, R.M., 1999. Astronomical Journal. 118, 752; Ashman, K.M., Zepf, S.E., 1992. Astrophysical Journal. 384, 50]. However, the formation and evolution of globular cluster systems is still not well understood. Ages and metallicities of the clusters are uncertain either because of degeneracy in the broad-band colors or due to variable reddening. Also, the luminosity function of the young clusters, which depends critically on the metallicities and ages of the clusters, appears to be single power-laws while the luminosity function of old clusters has a well-defined break. Either there is significant dynamical evolution of the cluster systems or metallicity affects the mass function of forming clusters. Spectroscopy of these clusters are needed to improve the metallicity and age measurements and to study the kinematics of young cluster systems. Therefore, we have obtained GMOS IFU data of 4 clusters in NGC1275. We will present preliminary results like metallicities, ages, and velocities of the star clusters from IFU spectroscopy.

Keywords: Star clusters; Mergers; Galaxy formation

☆ Based on observations obtained at the Gemini Observatory, which is operated by the Association of Universities for Research in Astronomy, Inc., under a cooperative agreement with the NSF on behalf of the Gemini partnership.

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doi:10.1016/j.newar.2005.10.013

Contents

1. Introduction

There are several competing scenarios for the formation of globular cluster (GC) systems of galaxies. Ashman and Zepf (1992) predicted that the merger of two disk galaxies would produce an elliptical with a bimodal GC color distribution. The blue clusters are Galactic-halo like clusters from the progenitor galaxies. The red population is formed during the merger from the metal-enriched gas in the disks. This hypothesis also helps explain why ellipticals have specific GC frequencies (number per unit luminosity) about a factor of two higher than spirals. The main alternative scenario is that all the clusters were formed "in situ", in a multi-phase collapse within a single potential (Forbes et al., 1997). In this case, the metal-poor clusters form first in the halo and metal-rich clusters form later during the final collapse stages from metal-enriched gas. A key test is whether the young star clusters discovered in galaxy merger remnants (e.g. Holtzman et al., 1992; Miller et al., 1997) survive to become old globular clusters. There are suggestions that the IMFs of young clusters may be top-heavy, meaning that the clusters are short-lived (Brodie et al., 1998), but more observations are needed.

2. Observations/reductions

NGC1275 was observed using GMOS on Gemini North with the Integral Field Unit (IFU). We used the B600 grating giving a linear dispersion of 0.47 Å/pixels and a resolution of 1.8 Å. The full spectral coverage was 4300–5400 Å. The advantages of the IFU are: (1) an effective slit width of 0.3″, for higher spectral resolution, yet no slit losses; (2) full 2-dimensional spatial coverage that will improve background subtraction in areas of variable background; and (3) the ability to correct for atmospheric dispersion (Arribas et al., 1998). Fig. 1. shows that a single $5'' \times 7''$ IFU pointing contains 5 clusters studied by Brodie et al. (1998). The data were reduced using the GMOS IFU script in the Gemini IRAF package (see poster by Carrasco et al. and talk by Turner et al.). Additional steps have been developed to improve sky subtraction and to correct for QE differences between the CCDs. Finally the data were combined and corrected for atmospheric dispersion using the EURO3D software.

3. General objectives

The primary objective is to measure equivalent widths of the Balmer absorption lines and standard Lick line indices for H, Fe, C2, and Mg for the young clusters in the center of NGC1275. These will be compared to the latest stellar population synthesis models (e.g. Bruzual and Charlot, 2003; Bressan et al., 1996; Vasdekiz, 1999) to determine the ages and metallicities of the clusters and to set limits on their IMFs. Hβ is used as an age indicator, while lines of Mg and Fe are metallicity indicators. This will show