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Understanding Circumnuclear Star Formation in Spiral Galaxies

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Abstract. We are attempting to learn the circumstances under which bursts of star formation may be triggered around the nuclei of many nearby spiral galaxies. By comparing the observed equivalent widths of the Brγ emission line and the CO(2–0) absorption band in each of the circumnuclear hotspots, with starburst models from the literature, we can place constraints on the age and duration of each star formation event. We present preliminary results obtained for M 100 (NGC 4321).

1. Introduction

Circumnuclear Star Formation (CSF), in which a host of compact, star-forming hotspots are confined in a tightly-wound spiral or ring pattern $\sim$ 1 kpc across, is most commonly observed in barred spiral galaxies. Dynamical models suggest that as gas is channeled inwards by the bar, it will accumulate near the Inner Lindblad Resonance, leading eventually to the onset of star formation. But what actually triggers the CSF? Is it when the gas density exceeds some critical threshold? Or perhaps it is the passage of a spiral density wave? To address this issue, we have begun a program of identifying, and then age-dating CSF regions in nearby disk galaxies.

As our age diagnostics, we use the equivalent widths of both the Brγ emission line at 2.16 μm, and the CO(2–0) band at 2.29 μm. About 5 Myr after star formation commences, the Brγ emission begins to decrease, while the CO absorption increases (Puxley, Doyon & Ward 1997; Leitherer et al. 1999), as the massive stars evolve to become red supergiants. Thus, the combination of these two features is a powerful age indicator, and also allows us to distinguish instantaneous bursts from continuous star formation (Fig. 1).

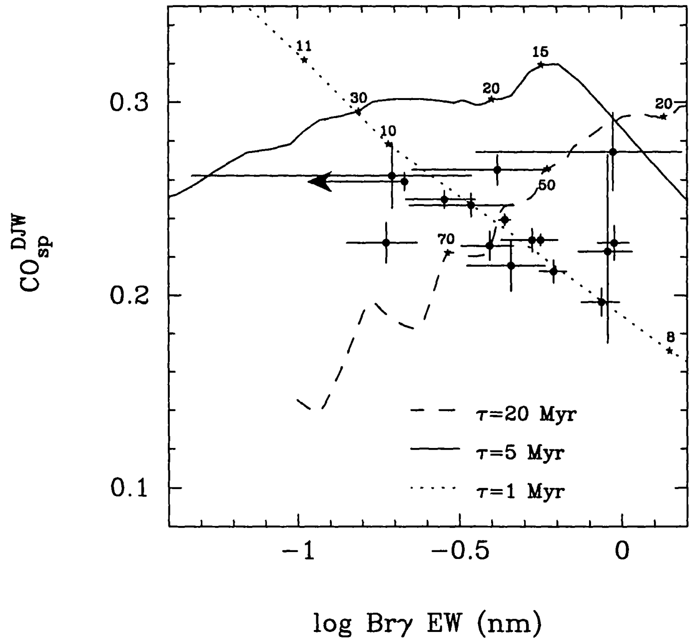

Figure 1. Plot of observed CO spectroscopic index vs. Brγ equivalent width for 16 of the CSF regions in M 100. Also shown are the evolutionary tracks for starburst models with decay timescale τ, reproduced from Puxley et al. (1997). Ages in Myr are marked on each track.

2. Circumnuclear Star Formation in M 100

We obtained low-resolution ($R \sim 450$) K-band spectra for 16 of the CSF regions in M 100 (Ryder & Knapen 1999) using CGS4 on UKIRT. The CO spectroscopic indices (using the definition of Doyon, Joseph & Wright 1994) are plotted against the Brγ equivalent widths in Fig. 1, on which we have overlaid the model evolutionary tracks from Puxley et al. (1997) for a starburst decaying exponentially with timescale τ. It can be seen that the majority of the CSF regions in M 100 can be accounted for by a quasi-instantaneous burst, with ages ranging from $8 - 10$ Myr. Although we cannot exclude the possibility that some of these regions are much older ($50 - 70$ Myr of constant star formation) on the basis of this plot alone, we have matching H_2 1–0 S(1) 2.12 μm data, which effectively excludes this possibility.

A more complete description of the observations, and a full analysis of the age distribution, can be found in Ryder, Knapen & Takamiya (2001).

References

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