Three Classical Cepheid Variable Stars in the Nuclear Bulge of the Milky Way

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The star formation history and the triggering process for star formation of the nuclear bulge of our Galaxy remain to be resolved. Classical Cepheid variable stars have pulsation periods that decrease with increasing age, so it is possible to probe the star-formation history. We have reported the presence of three classical Cepheids in the nuclear bulge with pulsation periods of approximately 20 days [1]. No Cepheids with longer or shorter periods were found. We infer that there was a period about 25 Myr ago, and possibly lasting until recently, in which star formation increased relative to the period of 30–70 Myr ago.

We conducted a near-infrared survey for the 0°.33 by 0°.5 area around the Galactic center [2], where no classical Cepheids were known before. The data were taken with the Infrared Survey Facility (IRSF) 1.4-m telescope and the SIRIUS near-infrared camera located at the South African Astronomical Observatory. Approximately 90 time-series images were collected in each of the J, H and K_S bands during eight years between 2001 and 2008, and three classical Cepheids were discovered on the basis of their light curves (Fig. 1).

All of our classical Cepheids have periods close to 20 days, suggesting their ages of 25 ± 5 Myr. We can estimate the star-formation rate at about 25 Myr ago by assuming an initial mass function and the lifetime spent by the Cepheid inside the instability strip, and find that the star-formation rate was $0.075^{+0.15}_{-0.05}\ M_\odot\ \mathrm{yr}^{-1}$ in the entire nuclear bulge 20–30 Myr ago. On the other hand, the absence of shorter-period Cepheids leads to $0.02\ M_\odot\ \mathrm{yr}^{-1}$ as a 1σ upper limit on the star-formation rate for 30–70 Myr ago. Thus we find the change in the star-formation rate between 20 and 70 Myr ago in the nuclear bulge.

A recent investigation suggested that the star formation rate was low a few tens of millions of years ago and then increased to a peak at about 0.1 Myr ago, followed by a decline in very recent times [3]. However, the tracers used give only a rough timescale for the range 1–100 Myr ago. Our estimates have much higher time resolution for the 20–70 Myr range and indicate an increase in star-formation rate within this period.

It is of interest to consider how and why such time variations in star formation occurred. Episodic star formation has been suggested in some of the so-called pseudobulges, the central regions of a few barred spiral galaxies, possibly growing with bar-driven gas inflow. Our result suggests that episodic star formation on a short timescale of about 25 Myr occurred in the nuclear bulge, which some authors claim to be a pseudobulge [4]. The timescale is comparable with that of the cyclic gas accumulation predicted for the central part of the Milky Way [5].

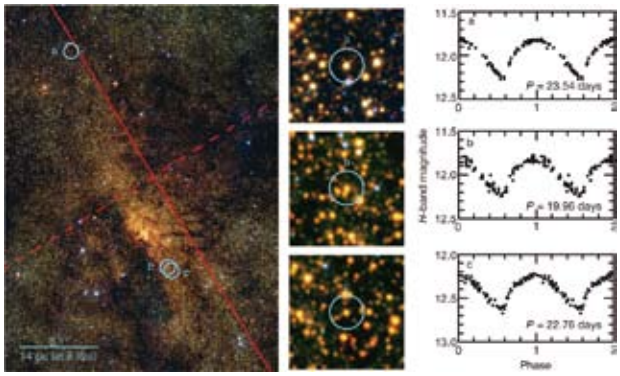

Figure 1: The classical Cepheids discovered in the Nuclear Bulge. The near-infrared false-color image (left), close-ups around the Cepheids (middle), and the H-band light curves are shown. The positions of the Cepheids are shown by blue circles.

References

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