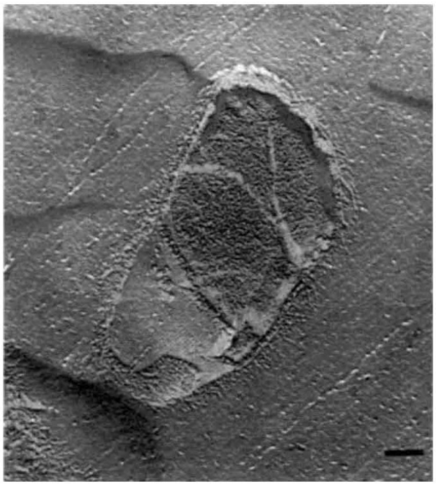

FIG. 2 Freeze-etched cells of *P. oshimae* showing the tetragonal S-layer. The more pronounced relief is due to prolonged (deeper) etching of the specimen. Bar, 200 nm. The concentrated cell suspension was frozen between two copper platelets in a cryojet (Baltec Jet Freeze Device FDJ030). Freeze-etching was carried out in a Balzers freeze-etch unit (BAF 400, Balzer AG) at –100 °C for 30 s. The fracture faces were shadowed with 2 nm of platinum–carbon at an elevation angle of 45°. The metal film was backed with a 10-nm carbon layer. Replicas were washed with water and kept overnight in 70% H_2SO_4.

of *T. acidophilum* and about 97% identity with a partial sequence of *P. torridus*. In contrast to *T. acidophilum*, both isolates possess a filigree tetragonal S-layer (Fig. 2) and a brush-like outer layer of short filaments possibly representing polysaccharide chains (H. Engelhardt, personal communication).

The G+C content of these isolates was found to be 36% as opposed to 46% for *T. acidophilum* and 38–40% for *T. volcanium*[5]. The DNA-dependent RNA polymerase of *P. oshimae* did not crossreact with an antibody against that of *T. acidophilum* in the Ouchterlony immunodiffusion assay[6]. These differences suggest that *Thermoplasma* and *Picrophilus* represent different families of the order Thermoplasmales. The bisphytanyl tetraether lipids are dominated by a single phosphoglyco component and resemble those of *T. acidophilum* (A. Gambacorta, personal communication).

One important physiological question raised by these findings is how these hyperacidophiles cope with their harsh environment — with a strong proton pump or a low proton membrane permeability?

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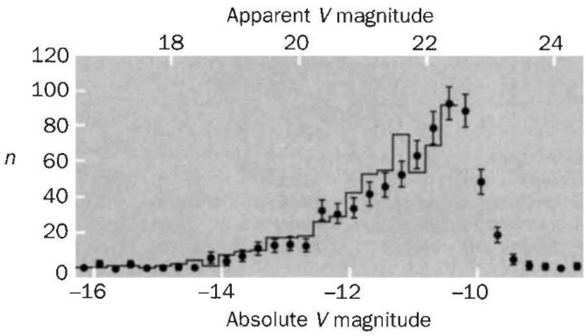
Star clusters in merging galaxies

SIR — Whitmore and Schweizer[1] showed that the merging galaxy pair NGC4038 and NGC4039 contains hundreds of young, luminous, 'super' star clusters (SSCs) and hypothesized that these may be proto-globular clusters. van den Bergh[2] challenged this interpretation by arguing that the distributions of luminosities and sizes of the SSCs are unlike those expected for young globular clusters. I will show that this hypothesis is not yet refuted.

The Hubble Space Telescope (HST) is discovering ever more SSCs. Their hosts can be classified as starburst galaxies, many of which, like NGC4038/4039, are merging systems. When the nearest star bursts are examined, it is clear that SSCs are themselves highly clustered. For example, there are about 50 SSCs in region A of the prototypical starburst M82 (ref. 3). Their nearest-neighbour projected separation is typically ≤ 18 pc (assuming a distance $D = 3.6$ Mpc). Whitmore and Schweizer estimated cluster half-light radii, $R_{\rm eff}$, from HST images by modelling the difference in brightness of the cluster in two circular apertures of projected radii 7 and 43 pc for $D = 29$ Mpc. Their large-aperture measurements are thus likely to be contaminated by neighbouring SSCs, which would inflate their $R_{\rm eff}$ estimates. The SSCs in M82 typically have $R_{\rm eff} = 1.8$ pc (ref. 3) if one assumes their intrinsic profiles to be gaussian. Thus, when one considers the nearest SSCs, the measured $R_{\rm eff}$ sizes are consistent with globular clusters that typically have $1 \lesssim R_{\rm eff}/(1\ {\rm pc}) \lesssim 6$ (ref. 2).

Galactic globular clusters are so old compared with their age spread that they are of effectively the same age, and the globular cluster luminosity function reflects only the mass function. The comparison shown by van den Bergh assumed that the SSCs are also of the same age. The blue colours and associated emission-line nebulae of some of the SSCs, however, indicate that cluster formation is still occurring in NGC4038/4039 and probably has been since the two galaxies made their last close approach about 200 million years ago[4]. An SSC's V-band luminosity is expected to fade by 1.7 mag in its first 200 Myr (ref. 5). This will significantly broaden the luminosity function and push its peak to a fainter magnitude than the luminosity function shown by van den Bergh.

Comparison of the NGC4038/4039 SSC luminosity function with a Monte-Carlo simulation of forming globular clusters provides a good representation of the observed luminosity function (see figure). Simulations with the same assumptions also match the SSC colour–magnitude and two-colour diagrams of Whitmore and Schweizer. The hypothesis that the clusters in NGC4038/4039 are young globular clusters can thus account for the observed cluster luminosity function. Also, crowding effects are likely to have inflated Whitmore and Schweizer's $R_{\rm eff}$ measurements, causing the disparity with globular cluster sizes.



The V-band luminosity function of super star clusters in NGC4038/4039. The number (n) of clusters at a given magnitude is counted in 0.5-mag bins. The top axis shows apparent magnitude, the bottom axis absolute magnitude. A uniform foreground extinction of $A_V = 0.5$ mag is assumed[1]. The data points are the observations taken from Table 1 of ref. 1, with error bars showing $\sqrt{n}$. The solid line shows the simulation, including only the clusters with $m_V > 22.5$. The SSCs are assumed to have formed at a constant rate for 200 Myr, with a globular cluster-like initial mass function taken to be a gaussian in logarithmic mass, centred at 5.1 ($\log(M_\odot)$) with a dispersion of 0.52 (refs 5, 6). The number of clusters formed in the simulation (1,160) was chosen so that the number with $m_V \leq 22.25$ matches that in NGC4038/4039. Other assumptions used in the simulation are the most natural for globular clusters in the NGC4038/4039 system and do not represent a fit to the data. The sharp drop-off at fainter magnitudes is due to the limiting magnitude of the observations.

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