3. Star Formation and Starbursts

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LONG-TERM STAR FORMATION AT THE GALACTIC CENTER AND ITS EFFECT ON THE STELLAR POPULATION

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Star formation presently occurs in our Galactic nucleus at a rate of several 10^{-1} $M_\odot$ yr^{-1}. If this value represents the long-term average, some 10^9 $M_\odot$ of stars should have been generated in our Galaxy's central few hundred parsec volume over the Milky Way's lifetime. As the expected stellar yield is actually in rough agreement with the mass of our Galaxy's bright near-infrared "central r^{-2} cluster", it is possible to hypothesize that this massive "nuclear" cluster is in fact the product of long-term nuclear star-formation, rather than being a remnant of the Galaxy's formation epoch. Several lines of evidence supporting this hypothesis are laid out in Serabyn and Morris (1996), to which the reader is referred for a complete discussion and reference list; here only a brief summary of the main arguments is presented.

Currently, the central few hundred parsec nuclear volume of our Galaxy is home not only to a dense stellar cluster, but also to a compact layer of dense molecular clouds. This layer, which is highly flattened along the Galactic plane, is the raw material out of which nuclear star-formation proceeds. However, with a current mass of $\approx 5 \times 10^7$ $M_\odot$, the material in our Galaxy's central molecular zone would be consumed on a timescale of $\approx 10^8$ yr without replenishment. To generate stars over an extended period, our Galaxy's nuclear interstellar medium must thus be fed at a rate comparable to the star-formation rate. This condition is evidently approximately met, as estimates for inflow rates into the nucleus (resulting from e.g., a bar-like asymmetry in the Galactic gravitational potential) also tend to fall in the few 10^{-1} $M_\odot$ yr^{-1} range. The idea of sustained star-formation in our Galaxy's nucleus is therefore viable. This is not to say that nuclear star-formation is continuous or steady; in fact it may occur in repeated or even cyclical bursts of star-formation far in excess of the average rate. Thus, what is meant is that inflow into our Galactic nucleus could sustain

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a long-term *average* star-formation rate of several 10^{-1} $M_\odot$ yr^{-1}.

It is of course possible to search for the offspring of such star formation. In particular, the prediction is for a flattened intermediate-age stellar cluster of $\approx 10^9$ $M_\odot$ in our Galaxy's nucleus. Now, it is well established that a sizable cluster of red giants is located in our Galaxy's central hundred parsecs. However, due to high extinction, and the resultant lack of direct information on the accompanying main sequence stars, this cluster's true nature and age remain ill-defined. In fact, mainly because its shape is well-described by a power law profile of index ≈ 2, which is the exponent expected for a relaxed, isothermal stellar cluster, the default viewpoint has been that this cluster is old and bulge-like. However, as collisional star-formation in a molecular disk can also yield an r^{-2} stellar number density profile, an r^{-2} profile is then by itself not an indicator of advanced age.

The r^{-2} cluster is sometimes portrayed as the innermost part of the galactic bulge population, but in fact our Galaxy's elderly kpc-scale bulge has a shape quite different from the smaller scale nuclear cluster at its center. First, the bulge's profile is described by a much steeper power law, with an exponent ≈ 3.5. Second, the bulge is less flattened (of course extinction limits our knowledge of this issue). Third, on large-scale near-infrared maps of the Galactic bulge, the nuclear cluster appears as a bright excess at the center of the bulge, suggesting that the nuclear cluster and bulge are distinct components. Finally, kinematic measurements of both OH/IR stars and red giants in the nuclear cluster reveal the importance of cluster rotation, again supporting the notion of a non-bulge population.

However, most damning for the "primordial" nuclear cluster scenario is the fact that several observed sites of ongoing star-formation indicate directly that the nuclear cluster is currently growing. Indeed, the stars comprising several young, pc-scale, $\approx 10^4$ $M_\odot$ clusters have recently been added to the overall 100 pc scale nuclear cluster, and OH/IR stars seem to flag earlier episodes of star formation as well. It is thus inescapable that some fraction of the nuclear cluster is of intermediate age, built up from numerous earlier star-formation events like those currently seen. Indeed, even if the average past nuclear star formation rate was no higher than at present, an intermediate-age stellar population of $\approx 10^9$ $M_\odot$, roughly the observed mass of the present day nuclear cluster, would have emerged over the Galaxy's lifetime. Thus, an advanced, bulge-like age for the bulk of the r^{-2} cluster is possible only if we are currently fortuitously witnessing an *elevated* star formation rate in our Galaxy's nucleus, which is not likely to be the case, given its relatively modest level.

References

Serabyn, E. & Morris, M. 1996, *Nature* 382, 602.

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