On the Nature of Star Formation in Cooling Flow Ellipticals

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We present evidence based on narrow band optical and near-IR imaging that field and cluster cooling flow galaxies are enriched in low mass stars as a result of recent, truncated IMF star formation from accreting gas. We imaged 25 normal and 6 cooling flow ellipticals using a narrow blue band system. All galaxies have similar mean colors and color gradients. Near IR surface photometry was obtained for three normal ellipticals, three cooling flow ellipticals, and three cluster cooling flows.

Galaxies with low accretion rates ($\dot{M} < 5\,M_{\odot}$ yr^{-1}) have normal optical colors and color gradients, but red $V-K$ colors. The metallicity of these galaxies can be estimated using the narrow band $v-y$ color. The $v-y$ color is the same for all galaxies in the sample. The metallicity gradients derived from the $v-y$ radial color gradients can be converted to Mg_2 or [Fe/H] gradients to compare these new data to the literature. The $V-K$ color is also dependent on metallicity. For the galaxies studied, the [Fe/H] gradients derived from $v-y$ are the same as [Fe/H] gradients found using independent methods. (Thomsen and Baum, 1989). We then interpret the red $V-K$ colors of cooling flow galaxies as not a metallicity effect but an effect coming from star formation with an IMF enhanced in low mass main sequence stars.

Cluster cooling flow ellipticals ($\dot{M} > 50\,M_{\odot}$ yr^{-1}) display characteristics of weak bursts of star formation (i.e. blue optical colors - see Fig. 1). If one assumes a normal IMF, an upper limit on the total amount of star formation can be calculated because of the size of the blue color excess. The blue colors imply that only about 5% of the cooling flow mass turns into stars with a normal IMF. Red $V-K$ colors are also found in cluster cooling flow galaxies indicating that the remaining mass forms low mass stars.

The cooling flow galaxies in our sample have been plotted on a $V-K$, $U-V$ color-color diagram (Fig. 1). Also on this diagram, expected colors for given IMF's are plotted. For each IMF, the integrated colors are a function of $[Fe/H]$. The more metal rich, the stellar population, the redder the colors. For reference, two lines of constant $[Fe/H]$ are plotted in figure 1. The functional form of the IMF goes as mass$^{-(1+x)}$. The Salpeter IMF (x=1.35) is plotted, as well as an IMF dominated by low mass star formation (x=3.00). Normal ellipticals cluster about and x=2 IMF but the cooling flow ellipticals are consistent with an IMF of higher x.

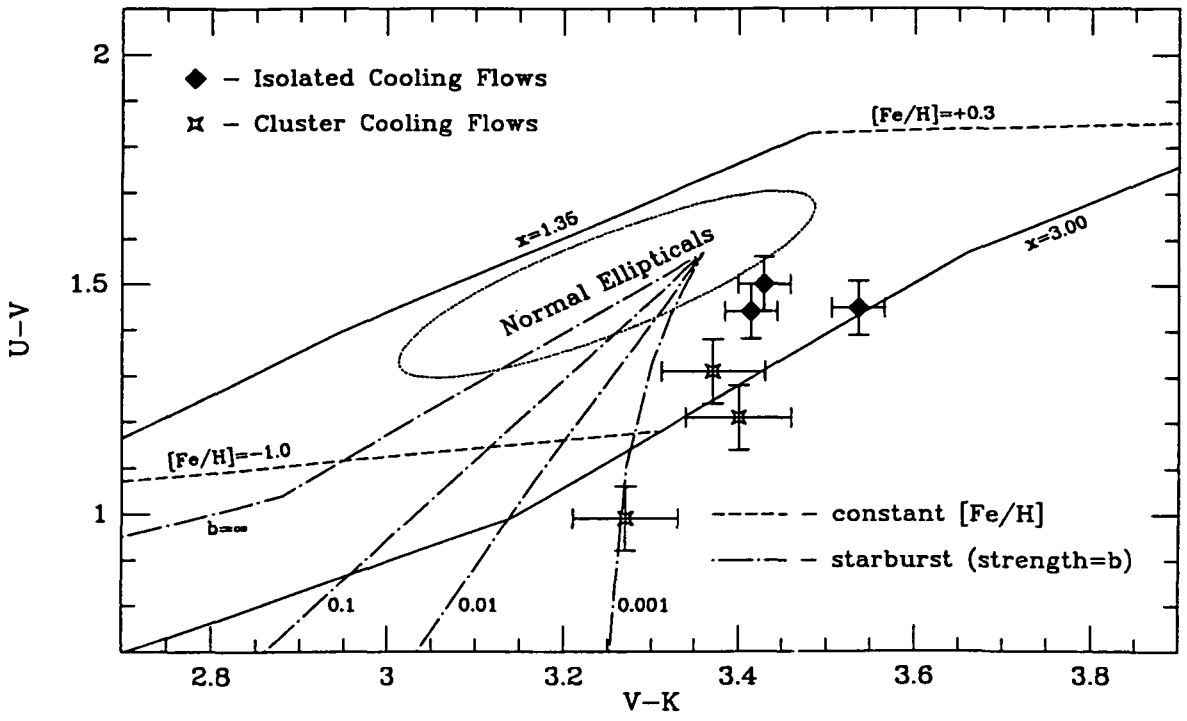

Figure 1. The optical to near-IR two color diagram. Solid and dashed lines show models for varying IMF and metallicity. Dash-dot lines show models of starbursts for various strengths (b = mass of new stars/mass of galaxy). Dotted ellipse is the region occupied by normal ellipticals.