

extragalactic star-forming regions and open clusters of the Milky Way*

F. Sakhibov^{1,2}, A.S. Gusev³, N.V. Kharchenko³ A.E. Piskunov¹

¹Giessen-Friedberg University for Applied Sciences, Friedberg, Germany ²Institute of Astrophysics, Academy of Sciences of Tajikistan, Dushanbe, Tajikistan

³Sternberg Astronomical Institute, Moscow, Russia

⁴Main Astronomical Observatory National Academy of Sciences of Ukraine, Kiev, Ukraine

⁵Institute of Astronomy of the Russian Academy of Sciences, Moscow, Russia

We have carried out a comparative analysis of the evolution of integrated photometric parameters of young star-forming complexes in spiral and irregular galaxies and Galactic open clusters. We find, that when the interstellar extinction is properly taken into account the extragalactic complexes observed as giant HII regions and open clusters in the Milky Way make a single evolutionary sequence of objects evolving at different stages.

The extragalactic Star-Forming Complexes (SFCs) are conglomerates of recently formed star clusters embedded into gas-dust clouds. Due to high luminosity they are easily seen in outer galaxies, whereas in the Milky Way they are either lost in the rich stellar background, or screened with the dense dust clouds. Because of high Lyman continuum fluxes from O- and early B-stars (spectral type B0-B2) SFCs are visible as giant HII regions in external galaxies.

We use a sample of more than 100 SFCs from 18 spiral and irregular galaxies with known ages and photometry (integrated magnitudes $I(M_V)$ and colors $I(B-V)$). (Sakhibov and Smirnov 1999, *Astron.Rep.* 76, 419; 2000 *A&A* 354, 802). The reddening was determined from comparison of observed and theoretical values of the Balmer decrement. Ages were determined from comparison of true colour-indexes with a grid of the evolutionary models of star clusters (Piskunov and Myakutin 1996, *Astron.Rep.* 73, 520, *INASAN* hereafter).

Open clusters of the Milky Way are typical objects of the Galactic disk. Based on the All-Sky Compiled Catalogue of 2.5 mln stars (ASCC-2.5; Kharchenko 2001, *CDS I/280A*), we have investigated 650 local Galactic clusters (Kharchenko et al. 2005a,b, *A&A*, 438, 1163; *A&A*, 440, 403; Piskunov et al. 2008, *A&A*, 487, 557). A uniform combined kinematic-photometric cluster membership has been established and a homogeneous set of OC parameters (sizes, kinematics, distances, reddening, ages, masses, integral magnitudes and colours) have been determined. This data set presents a representative sample of star clusters, which can be used as a touchstone for extragalactic clusters. Unlike to local star clusters with the parameters determined directly from different resolved diagrams, for the most of extragalactic clusters parameters are determined indirectly from the analysis of their integrated light.

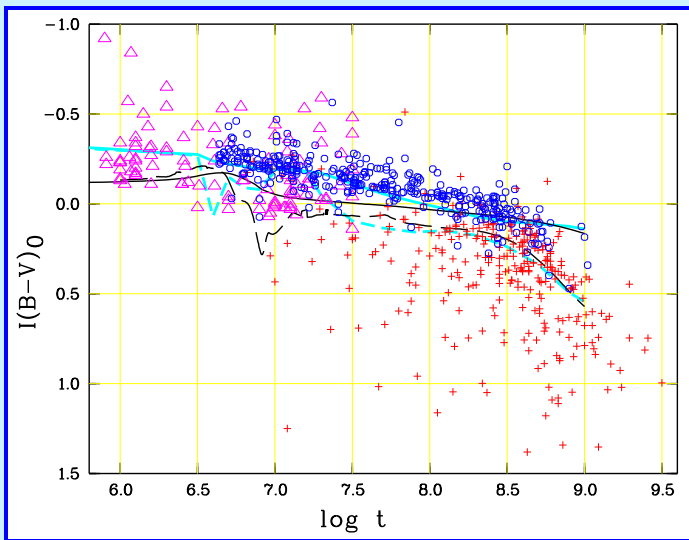


Fig. 1: Comparison of extragalactic SFCs and Milky Way open clusters in the integrated colours vs. $\log t$ diagram. Magenta triangles are extragalactic SFCs; blue open circles and red pluses mark open clusters without and with Red Giant members. Thick lines are INASAN models, thin lines are SB99 models, version 5.1 (Vázquez and Leitherer 2005, *ApJ* 621, 695). The both models are constructed with the Salpeter IMF ($\alpha = -2.35$). Models with continuous and burst-like star-formation are shown by solid and dashed curves respectively. Colour indexes of SFCs are dereddened with observed Balmer decrement $A_V(\text{Balmer})$.

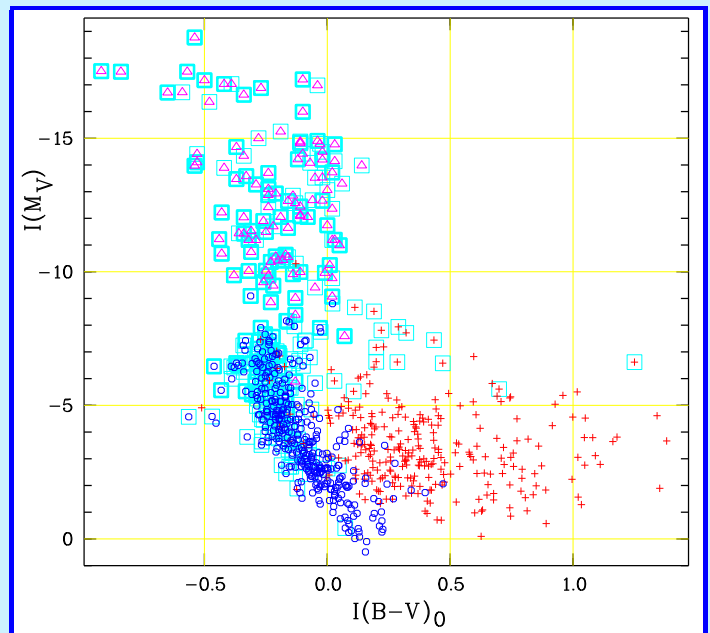


Fig. 2: Comparison of extragalactic SFCs and Milky Way open clusters in the integrated colour-magnitude diagram. The symbol designations are the same as in Fig. 1. Additionally: younger objects ($\log t < 7.5$, $t < 32$ Myr) are outlined with thin cyan squares, the youngest ones ($\log t < 6.81$, $t < 6.5$ Myr) with thick squares. Colour indexes of SFCs are dereddened with observed Balmer decrement $A_V(\text{Balmer})$.

Conclusions

As we know, the diagram presented in Fig. 1 is the first observed indication of well known scenario of an evolution of extragalactic giant HII regions into ordinary (alike Pleiades/M45) open clusters domain. Thereby one can propose that extragalactic SFCs, and Milky Way OCs build up a single evolutionary sequence. Fig.1 also shows that there is no difference between the radiation extinctions in gas emission lines and stellar continuum.

Fig. 2 illustrates the mutual location in the CMD of the Galactic open clusters and star forming complexes in the external galaxies.

* This study was supported by the DFG grant 436 RUS 113/757/0-2, and RFBR grant 07-02-91566. AG thank for the support by the Russian President grant for young Russian scientists MK-4818.2007.2.