Grown up with the VO
(a VO-powered PhD thesis)

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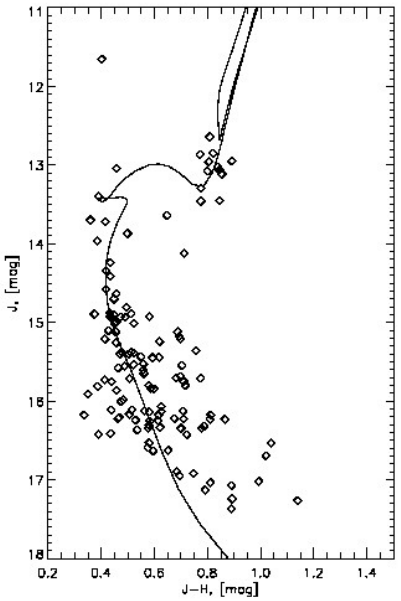
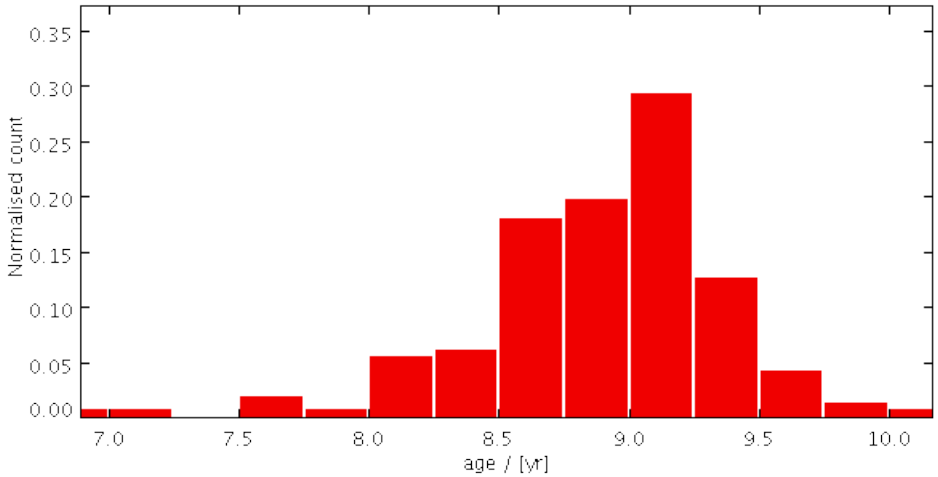
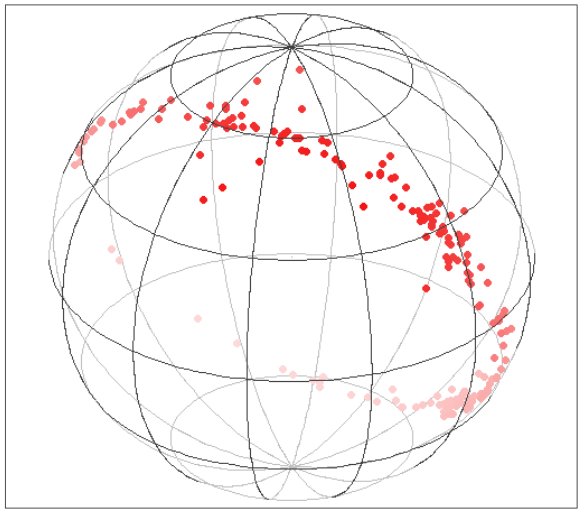
The Virtual Observatory has reached sufficient maturity for its routine scientific exploitation by astronomers. To prove this statement, here we present a complete VO-powered PhD thesis successfully defended on Oct 1, 2009, comprising 4 science cases covering several aspects of Galactic and extragalactic research. These includes: (1) homogeneous search and measurement of main physical parameters of Galactic open star clusters in huge multi-band photometric surveys; (2) interpretation of optical-to-NIR colors of nearby galaxies using a large homogeneous dataset including spectroscopy and photometry from SDSS and UKIDSS; (3) study of faint low-mass x-ray binaries population in modern observational archives, imposing physical constraints on this poorly-studied type of objects; (4) search for optical counterparts of unidentified x-ray objects with large positional uncertainties in the Galactic Plane. All these studies make heavy use of VO technologies and tools and would not be achievable without them. So refereed papers published in the frame of this thesis can undoubtedly be added to the growing list of VO-based research works.

1. SAI Open Clusters Catalog

We developed an automated method to search for open clusters in large multi-band surveys. It finds star density peaks and tests their color-magnitude diagrams fitting an isochrone there (see example on the upper right). If fit converges we consider peak to be a real cluster and at the same time get an estimate of the age, distance, color excess for it. We applied this method to the 2MASS data in the stripe |b| < 24 degrees along Galactic Plane and found 168 new open clusters (see their distribution by the age and on a sphere at the bottom left and right correspondingly) which is ~25% increase of the information about this important subsystem of the Galaxy. The results of the undergoing study, SAI Open Clusters Catalog, are presented in a VO-ready form at dedicated web-site http://ocl.sai.msu.ru .

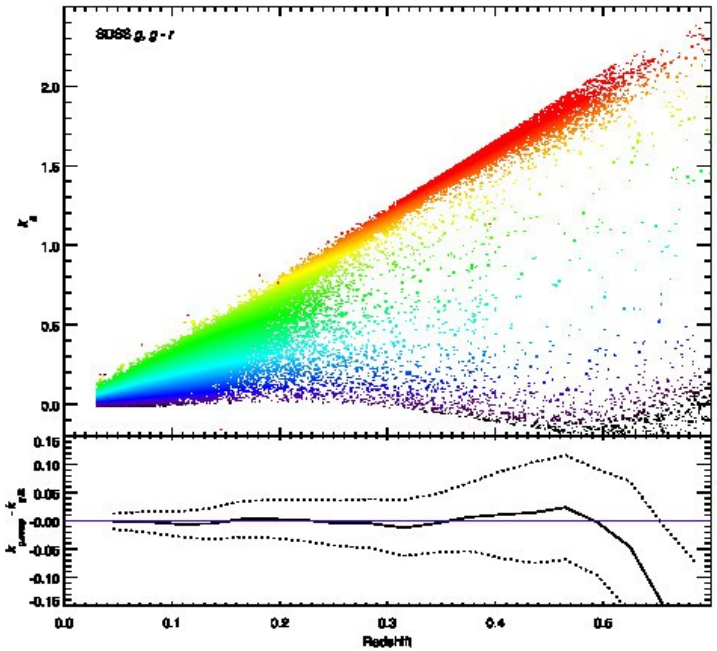




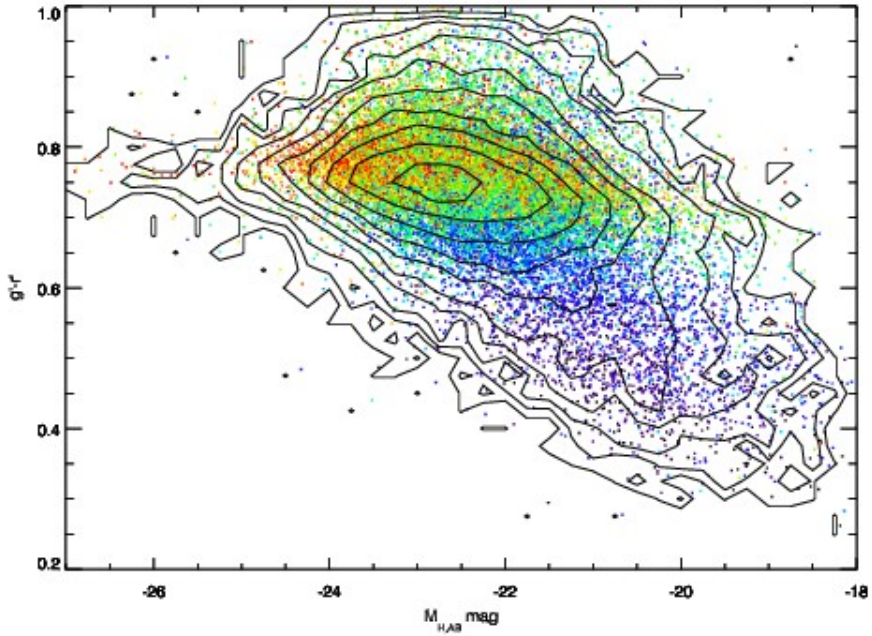


2. Optical-to-NIR colors of nearby galaxies

We cross-identified a spectral sample of SDSS DR7 galaxies lying at 0.03 < z < 0.6 with UKIDSS DR5 data, and fitted their spectra with simple stellar population models thus constructing a catalog of 200k galaxies with *ugriz* and YJHK photometry measurements, redshifts, spectra, ages and metallicities. This allowed us to determine an analytical approximation of *k*-corrections having great practical value for extragalactic research.

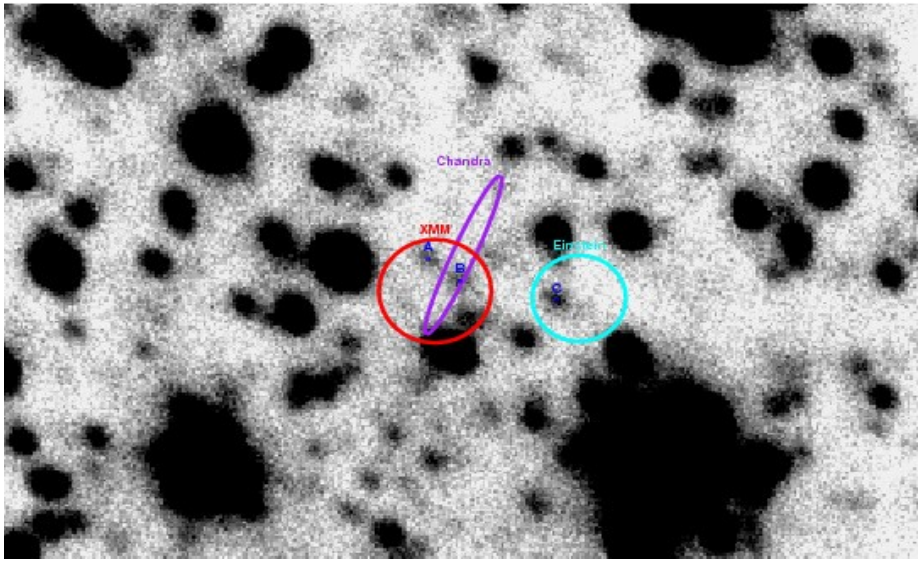


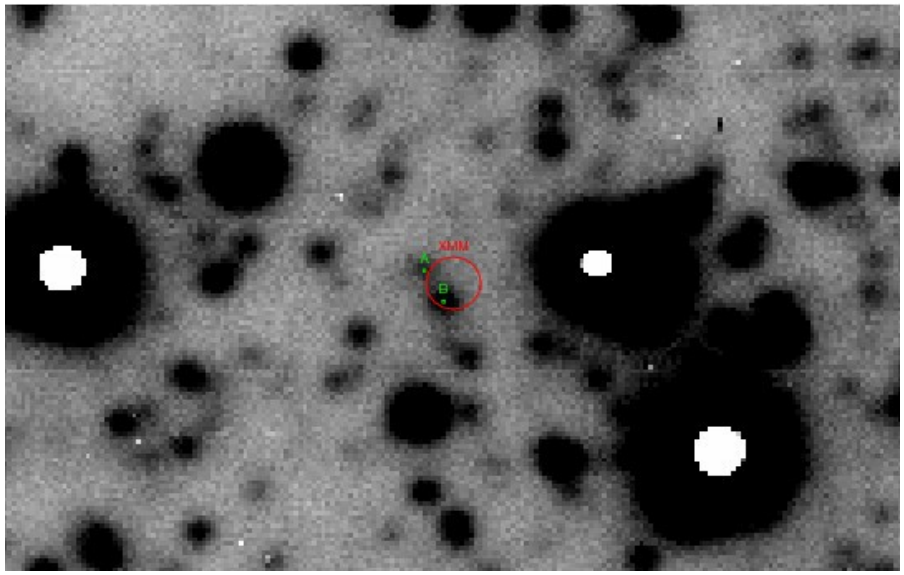
Analytical approximations of *k*-corrections in SDSS filter *g* as a function of observed color *g-r* (color-coded) and redshift (upper panel) and differences between analytical approximation and direct estimation of *k*-corrections from the spectra (bottom panel).

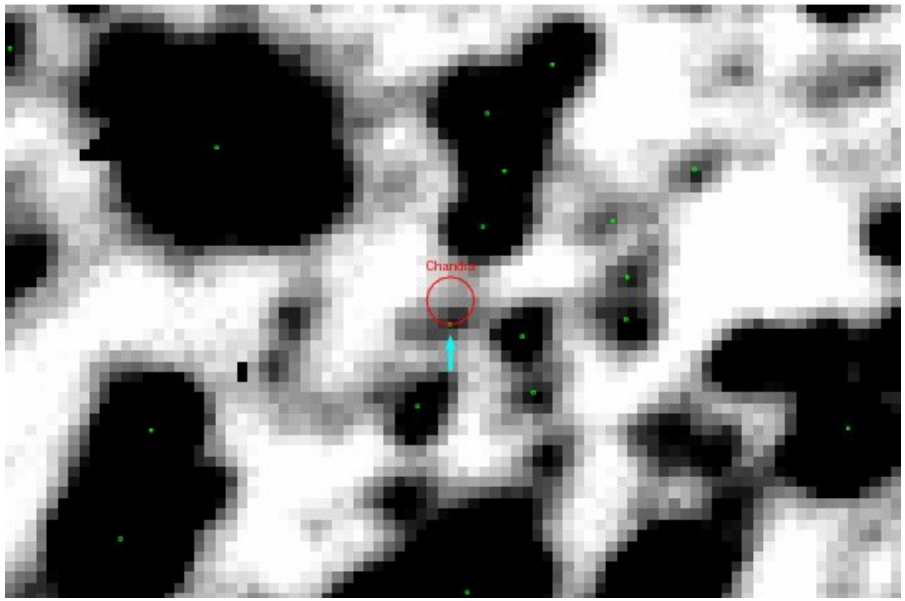


Color-magnitude diagram M_H vs. *g-r* (*k*-corrected) for nearby galaxies. Ages from 1 to 12 Gyr are color-coded from violet to red. 3 mag bright tail of the red sequence galaxies indicates that they cannot be formed from the merging of a blue cloud objects.

3. Optical/IR LMXB identification







Fields of three low mass x-ray binaries 4U1323-619, IGR J17254-3257 and SLX 1735-269 (see pictures clockwise) identified in archival data (ESO, Chandra, XMM archives used). In the case of 4U1323-619 there was a wrong identification based on Einstein x-ray observations with underestimated error radius.

4. X-ray sources in the Galactic Plane

With the help of IPHAS (INT Photometric H-alpha Survey) we identified an x-ray source AX J194939+2631 from ASCA Galactic Plane Survey that initially had 1 arcmin positional uncertainty. Upper right: color-color diagram of IPHAS detections in 1 arcmin field around ASCA coordinates of the source; three measurements of the potential counterpart demonstrating H-alpha emission excess are shown in squares. Bottom right: direct H-alpha image from IPHAS, the candidate marked with an arrow. Lower left: optical spectrum of the source obtained at 3.5m Calar Alto telescope, time granted in DDT quota on a basis of the input from the VO shown on this page. Source Is appeared to be a cataclysmic variable.