DOI: http://dx.doi.org/10.18524/1810-4215.2016.29.85171

ANALYSIS OF ASTEROID'S OBSERVATIONS IN OPEN PHOTOMETRIC DATABASES

A. Pomazan , N. Maigurova
Research Institute "Nikolaev Astronomical Observatory",
Observatorna 1, 54030, Mykolaiv, Ukraine, *antpomaz@gmail.com*

ABSTRACT. Today there are several open photometric databases containing important information for the study of the physical properties of asteroids. These databases are based on the results of various measurements of the different sets of objects. The study of statistical correlations between the various databases could significantly expand the list of asteroids with known physical parameters. We present the results of the comparative analysis of the determination of the albedo, diameters and absolute magnitudes of asteroids of five open sources (AKARI, IRAS, NEOWISE, HORIZONS and Pan-STARRS1). The infrared survey WISE (relatively to asteroids is NEOWISE project) and photometric survey Pan-STARRS1 are the widest databases of the absolute magnitudes and the albedo of asteroids providing information about 139356 and 248457 objects respectively. These surveys contain 73301 common asteroids. The obtained statistical relationships between the databases based on a common set of asteroids are presented.

Keywords: photometry observations, astronomical database, catalogs, asteroids

1. Introduction

Photometry is one of the main methods for studies of asteroids. Due to intensive photometric observations of asteroids in the last decades, huge information about the absolute magnitudes, periods of rotation around principle axis, sizes, shapes, colors and other characteristics of large number of asteroids was received.

According MPC database, the number of currently known asteroids with well-defined orbits is more than 720 thousands. Many ground-based (Pan-STARRS, SDSS MOC and etc.) and space (IRAS, AKARI, NEOWISE and etc.) surveys offer as well precisely determined orbital elements as a data of the photometric properties of asteroids. However, since each of the projects aimed to achieving specific goals they could provide a different set of photometric data. Analysis of the available data is a first step for further research of selected class of objects.

2. Brief overview of investigated photometric databases

5 surveys provided the photometric data were chosen for further investigation: IRAS, AKARI, NEOWISE, Pan-STARRS and SDSS MOC-3.

IRAS – Infrared Astronomical Satellite (Neugebauer et al., 1984), launched in 1983. The asteroid catalog was provided by Tedesco et al. (2002) as the supplemental IRAS minor planet survey (SIMPS). The SIMPS includes information for 2,470 asteroids.

AKARI – Japanese infrared satellite (Murakami et al., 2007), launched in 2006. The Asteroid catalog using AKARI (AcuA) (Usui et al., 2011) provides information for 5120 asteroids.

NEOWISE – is asteroid-hunting project of the Wide-field Infrared Survey Explorer (WISE) (Mainzer et al., 2011) mission. NEOWISE identified over 157,000 asteroids. 139356 asteroids were chosen from open databases for this research.

Pan-STARRS – the Panoramic Survey Telescope & Rapid Response System started operations in 2010 (Kaiser et al., 2010). The available data for 248457 asteroids (Veres et al., 2015) were used.

SDSS MOC – The Sloan Digital Sky Survey Moving Object Catalog provides information for all moving objects identified in the SDSS images. This data set contains Sloan Digital Sky Survey (SDSS) asteroid photometric observations classified according to the SDSS-based Asteroid Taxonomy (Carvano et al., 2010). This actual data set is the result of the taxonomic classification of third version of the SDSS MOC and contains 63468 asteroids. The SDSS MOC-4 is now available but not considered here.

Table 1 presents the availability of selected parameters in investigated surveys: the asteroid absolute magnitude (H), slope parameter (G), geometric visible albedo (pV), diameter (D), spectral type and the total number of asteroids.

Table 1. The availability of selected parameters in investigated surveys.

	H	G	pV	D	Spectral type	Data volume
IRAS	X		X	X		2470
AKARI	X	X	X	X		5199
NEOWISE	X	X	X	X		139356
Pan-STARRS	X	X			X	248457
SDSS MOC-3	X				X	63468

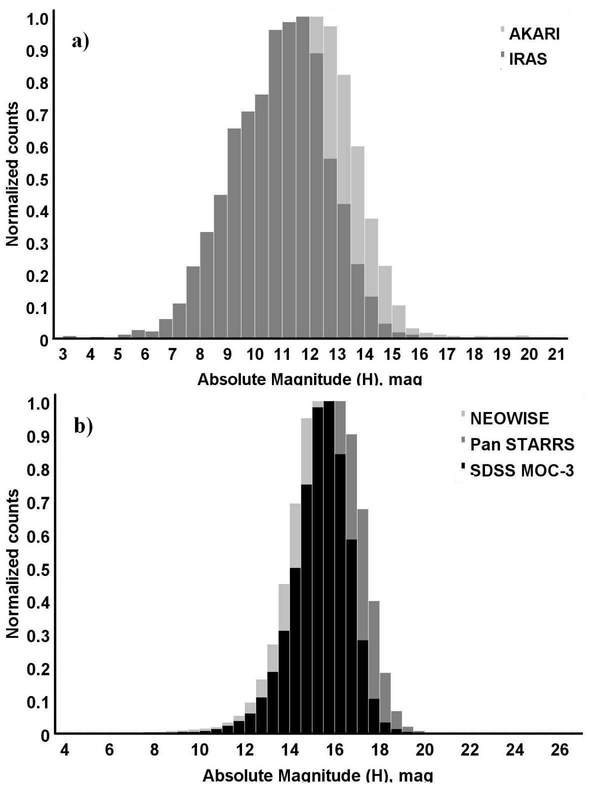

Figure 1: The distributions of absolute magnitude (H) values: a) – AKARI and IRAS surveys, b) – NEOWISE, Pan-STARRS and SDSS MOC-3

As can be seen, only the values of the absolute magnitude are available in each of the surveys. This is due to that the absolute magnitude is the main photometric parameters and available almost in all databases of asteroid observations (including MPC). Other parameters are partially overlapped because each of surveys was conducted for specific aims.

There are 328524 unique asteroids in foregoing surveys due to overlapping lists of objects. The cross-identification between infrared surveys (IRAS, AKARI, NEOWISE) shows 1993 common asteroids (Usui et al., 2014). The number of common asteroids between widest surveys (Pan-STARRS, NEOWISE, SDSS MOC-3) is 17888, the number of common asteroids for all 5 investigated surveys is only 362.

3. Analysis of absolute magnitude H

AKARI: The absolute magnitude (H) and slope parameter G were taken from the Asteroid Orbital Elements Database (Bowell et al. 1994) of Lowell Observatory at the epoch of 2010.

IRAS: The H- and G-values were mostly received from the MPC in 2001, where they were determined from ground-based observations in visible wavelengths.

NEOWISE: The absolute magnitudes H were taken from the Light Curve Database (Warner et al., 2009) when available otherwise, the values were taken from the MPC's orbital element file.

SDSS MOC-3: The H values were computed from observations.

Pan-STARRS: The H values were computed using both the Muinonen et al. (2010) and Bowell et al. (1989) phase functions (hereafter M10 and B89 respectively) from their own observations.

In Table 2 presents differences in H values between all 5 surveys.

The histograms of distributions of the absolute magnitude in investigated surveys are presented in Figure 1.

The peaks of distributions of absolute magnitude are 10.97 for IRAS, 12.08 for AKARI, 15.2 for NEOWISE, 16.12 for Pan-STARRS B89, 16.18 for Pan-STARRS M10 and 15.4 for SDSS MOC3.

Table 2. The residuals of values of the absolute magnitude between 5 processed surveys.

Residuals	AKARI	IRAS	NEOWISE	Pan-STARRS Bowell'89	Pan-STARRS Muinonen'10
IRAS	0.00±0.11 count 2104				
NEOWISE	0.00±0.22 count 4798	-0.01±0.23 count 2305			
Pan-STARRS Bowell'89	-0.24±0.38 count 3881	-0.20±0.37 count 1797	-0.33±0.29 count 73412		
Pan-STARRS Muinonen'10	-0.30±0.38 count 3881	-0.25±0.36 count 1797	-0.38±0.29 count 73412	-0.05±0.03 count 247458	
SDSS MOC-3	0.01±0.08 count 1367	0.00±0.04 count 601	-0.07±0.24 count 25877	0.22±0.34 count 40689	0.28±0.34 count 40689

4. The slope parameter G

The parameter G is a one of parameters in phase function of brightness of asteroids. The slope parameter G determines how strongly the apparent brightness of an asteroid depends on the phase angle and accounts for the properties of scattered light on the asteroid's surfaces.

The vast majority of asteroids have no measured slope parameter so the average values of G=0.15 are used for all asteroids that do not have a reported appropriate value.

AKARI: The survey has 105 asteroids that have value of slope parameter G different from 0.15.

NEOWISE: The survey has 96 such asteroids.

Pan-STARRS: As described in Veres et al. (2015), a Monte Carlo technique was used to calculate the slope parameters G_{B89} and G_{M10} with initial estimates based on measurements by Pravec et al. (2012) and Oszkiewicz et al. (2012) respectively.

The dense area near $G_{B89}=0.2$ on Figure 2a and $G_{M10}=0.5$ on Figure 2b could be explained by initial values for the Monte Carlo simulations of G=0.15 for Bowell et al. (1989) phase function and G=0.53 for Muinonen et al. (2010) phase function.

The dense area in the Figure 2b with mean value near $G_{M10} = 0.2$ is due to a discontinuity in the two-parameter H, G_{12} phase function (Muinonen et al., 2010). This is caused by the Monte Carlo simulations performed by Veres et al. (2015), which have a propensity to drive the fitted G_{M10} value to 0.2 when the number of data points is small. This area contains about 30% of all G_{M10} values.

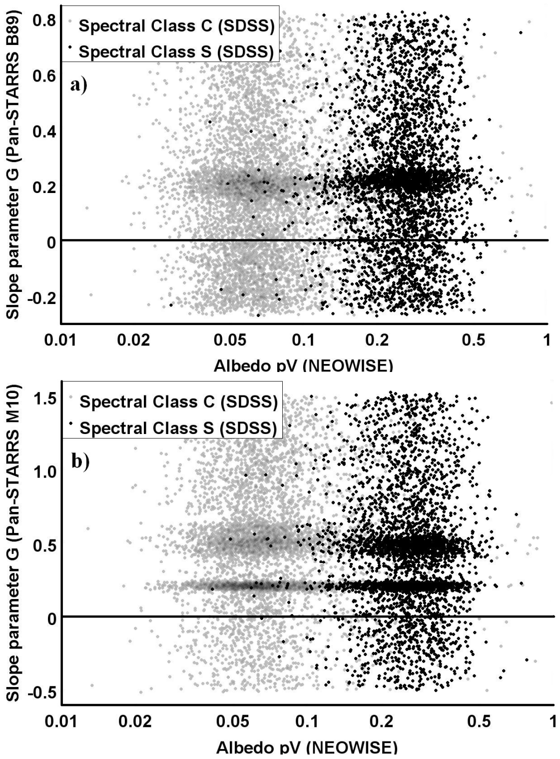

Figure 2: The slope parameter (Pan-STARRS) as function of albedo (NEOWISE) a) for phase function model of Bowell'89 and b) for Muinonen'10 for spectral class C (grey) and S (black).

5. Conclusions

Five photometric surveys (IRAS, AKARI, NEOWISE, Pan-STARRS and SDSS MOC-3) were analyzed and 328524 unique asteroids were identified. 17888 common asteroids were detected between widest surveys (Pan-STARRS, NEOWISE, SDSS MOC-3) and only 362 one are common for all five investigated surveys.

Each of these surveys contains different photometric parameters and only values of absolute magnitude (H) are available for all of them. The distribution of H is shifted toward to fainter object for newer surveys (SDSS MOC-3, 2004; NEOWISE, 2010, Pan-STARRS, 2012). The peaks of the distributions are in range from 10.97 for IRAS to 16.18 for Pan-STARRS M10.

Acknowledgements. This research has made use of the VizieR catalogue access tool, CDS, Strasbourg, France; Tool for OPerations on Catalogues And Tables (TOPCAT).

References

Neugebauer G. et al.: 1984, *ApJ*, **278**, L1.
Tedesco E. F. et al.: 2002, *AJ*, **123**, 1056.
Murakami H. et al.: 2007, *PASJ*, **59**, S369.
Usui F., et al.: 2011, *PASJ*, **63**, 1117.
Mainzer A., et al.: 2011, *ApJ*, **731**, 53.
Kaiser N. et al.: 2010, *GAT III, SPIE Proc.*, **7733**.
Vereš P. et al.: 2015, *Icarus*, **261**, 34.
Carvano J. M. et al.: 2010, *A&A*, **510**, A43.
Usui F., et al.: 2014, *PASJ*, **66**, 56U.
Bowell E. et al.: 1994, *ACM*, 477.
Warner B. et al.: 2009, *Icarus*, **202**, 134.
Muinonen K. et al.: 2010, *Icarus*, **209**, 542.
Bowell E. et al.: 1989, *Asteroids II Proc.*, 524.
Pravec P. et al.: 2012, *Icarus*, **221**, 365.
Oszkiewicz D. et al.: 2012, *Icarus*, **219**, 283.