Portal za analizu familija asteroida

Viktor Radović
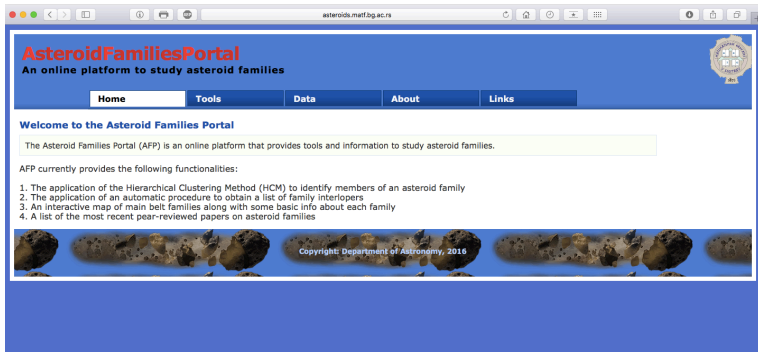
20. mart 2018

Asteroids Family Portal

- Značaj web portala u nauci?
- Asteroids Family Portal (AFP) - portal namenjen analizi familija asteroida
  - Identifikacija - HCM i izbacivanje uljeza
  - Fizički podaci
  - Metod integracije unazad
  - Katalog sopstvenih elemenata za GAP i MBC
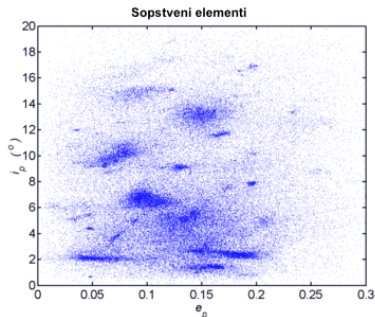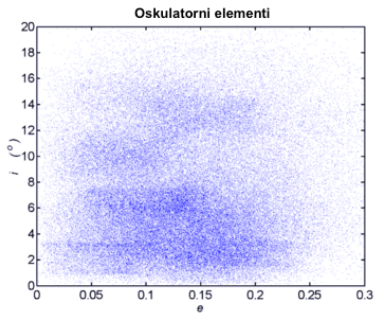 - Naučni radovi iz oblasti ....

Asteroids Family Portal - AFP

http://asteroids.matf.bg.ac.rs/fam/

Familije asteroida

- Oskulatorni (a, e, i) i sopstveni elementi asteroida (a_p, e_p, i_p)
- Hirayama, 1918

Sopstveni elementi

- Dinamički model: 7 planeta
- 10 miliona godina unapred
- Ista verzija softvera
- Šest meseci!
- http://asteroids.matf.bg.ac.rs/fam/properelements.php

AFP: Sopstveni elementi

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Proper Elements Catalogs

The catalogs contain proper orbital elements of numbered asteroids and main-belt comets computed numerically by means of a synthetic theory by Knežević & Milani (2000,2003).

There are however some differences between the procedure proposed by aforementioned authors and the one used to produce the catalogs available here:

- Orbits of all asteroids are numerically propagated for 10 Myr
- All numerical integrations are made within the same dynamical model
- All proper elements calculations are performed using the same version of the software

Asteroid proper orbital elements:

- afp.pro (file size: ~50MB)
- afp.sig (file size: ~40MB)

Proper orbital elements for main-belt comets:

- mbc.pro
- mbc.sig

Information on the format of the catalogs:

The format of files containing proper orbital elements of:

- Column 1: Asteroid number
- Column 2: Absolute magnitude
- Column 3: Proper semi-major axis [au]
- Column 4: Proper eccentricity

Familije asteroida: Identifikacija

- Metoda hijerarhijskog grupisanja (MHG, Zappalá et al., 1990)

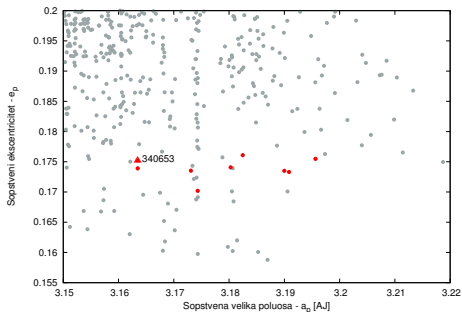$$d = na_p \sqrt{C_a(\delta a_p/a_p)^2 + C_e(\delta e_p)^2 + C_i(\delta \sin(i_p))^2}$$

Nominalno rastojanje d_{nom}

Rastojanje koje u prostoru sopstvenih elemenata najbolje opisuje familiju.

Familije asteroida: Identifikacija

Problemi

✗ Uljezi i lančano vezivanje (eng. chaining effect)

✗ Određivanje d_{nom}

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AFP: Identifikacija familija

Familije asteroida: Fizičke karakteristike

- Spektro-fotometrijske karakteristike
- Homogen vs. heterogen sastav familije
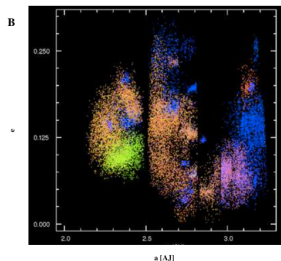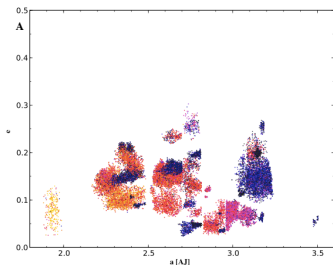
Taksonomija asteroida

- Taksonomija asteroida - podela u grupe na osnovu spektro-fotometrijskog sastava površi asteroida
  - C, S kompleksi
- Spektar
- Boje - SDSS
- Albedo - WISE, AKARI, IRAS

AFP: Fizički podaci

Familije asteroida: Identifikacija uljeza

- Migliorini et al., 1995
- Proširenje metrike MHG raspoloživim fizičkim podacima
  - ✓ Pouzdanije određena familija $\Rightarrow$ manje uljeza (Parker et al., 2008, Carruba et al., 2013)
  - ✗ Mali broj raspoloživih fizičkih podataka
  - ✗ Tačnost fizičkih podataka
- Izbacivanje uljeza direktno iz liste identifikovanih članova familije (Novaković et al., 2011, Milani et al., 2014, 2016)
  - ✓ Ne koristi si se smanjen skup podataka
  - ✗ Različiti kriterijumi za izbacivanje asteroida
  - ✗ Lančani efekat

Algoritam za izbacivanje uljeza

- **KORAK 1:** MHG se primenjuje na katalog sopstvenih elemenata (Knežević & Milani, 2000).

- **KORAK 2:** Identifikacija uljeza → SDSS boje, geometrijski albedo (WISE, AKARI, IRAS) i spektralni podaci.

- **KORAK 3:** Izbacivanje uljeza iz početnog kataloga.

- **KORAK 4:** MHG se primenjuje na modifikovanom katalogu.
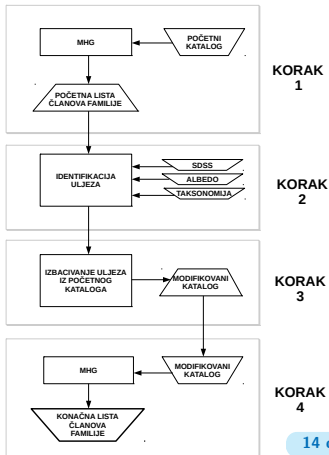
Rezultati (Radović et al, 2017)

Familija	d_{cut}	# STEP1	# SDSS	# ALBEDO	# TAX.	# STEP2	Vezivanje	# STEP 4	%
(5) Astraea	55	7482	92	295	2	361	234	6887	7.9
(10) Hygiea	70	5904	24	15	3	38	86	5780	2.1
(15) Eunomia	60	11889	411	1421	12	1595	316	9978	16.1
(20) Massalia	30	4663	7	8	0	13	2	4648	0.3
(24) Themis	70	5499	20	39	0	59	31	5409	1.6
(93) Minerva	75	7015	352	845	39	1057	-	-	-
(135) Herta	45	22849	465	1138	10	1358	1363	20128	11.9
(145) Adeona	45	1994	45	21	0	62	78	1854	7.0
(158) Koronis	65	7743	28	81	1	101	38	7604	1.8
(170) Maria	60	2939	20	28	0	45	44	2850	3.0
(221) Eos	70	24155	555	1706	39	2089	757	21309	11.8
(490) Veritas	30	1295	6	7	0	13	0	1282	1.0
(668) Dora	60	1401	9	3	1	13	0	1388	0.9
(847) Agnia	45	3054	14	52	0	61	84	2909	4.7
(1040) Klumpkea	80	2794	56	435	3	452	227	2115	24.5
(1726) Hoffmeister	40	1763	6	3	1	9	0	1754	0.5
(2076) Levin	45	2500	52	30	2	83	71	2346	6.2

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Diskusija

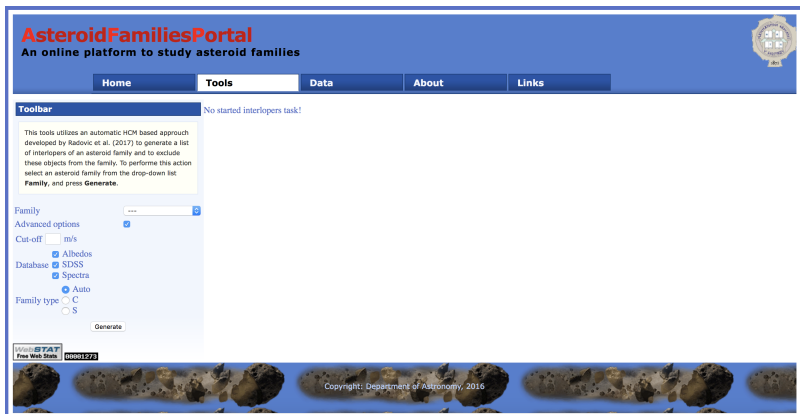## Prednosti

✓ Jasni i strogi kriterijumi za identifikaciju uljeza

✓ Uvođenjem novog koraka povećan je broj identifikovanih uljeza

✓ Redukovanje lančanog efekta ($> 10\%$)

✓ Pouzdanija lista članova familije

✓ Razdvajanje familija različitog tipa

Ograničenja

✗ Brojnost i kvalitet fizičkih podataka

✗ Preklapanje familija istog ili sličnog tipa

AFP: Izbacivanje uljeza

Familije asteroida: Metoda integracije unazad

- Trenutak formiranja familije $\rightarrow$ bliskost orbitalnih uglova
- Longituda uzlaznog čvora Ω i longituda perihela ϖ
- Dosadašnje procene? Najviše do 20 Mgod (Nesvorný et al., 2003; Novaković et al., 2010, Radović, 2017))

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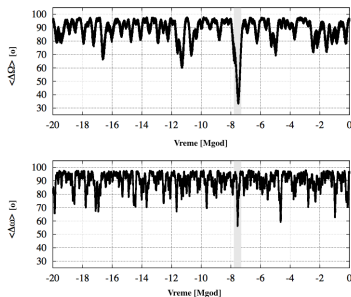
AFP: MIU
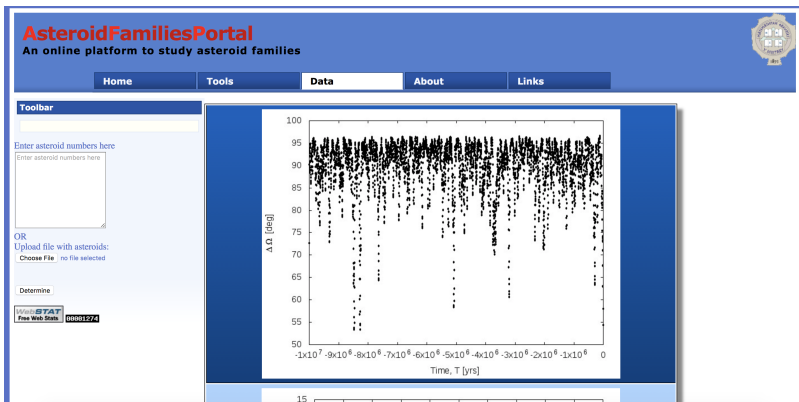
AFP: Papers

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Toolbar

Peer reviewed journal papers on asteroid families:

- 2018
- 2017
- 2016
- 2015
- 2014
- 2013
- 2012
- 2011
- 2010

Peer reviewed journal papers on asteroid families:

Year 2018:

Hsieh, H.H., Novakovic, B., Kim, Y., Brasser, R.:
Asteroid Family Associations of Active Asteroids
2018, *The Astronomical Journal*, **155** , 96

Pravec, P., and 18 colleagues:
Asteroid clusters similar to asteroid pairs
2018, *Icarus*, **304** , 110-126

Henych, T., Holsapple, K.A.:
Interpretations of family size distributions: The Datura example
2018, *Icarus*, **304** , 127-134

Rosaev A., Plávalová E.:
On relative velocity in very young asteroid families
2018, *Icarus*, **304** , 135-142

Benavidez, P.G., Durda, D.D., Enke, B., CampoBagatin, A., Richardson, D.C., Asphaug, E., Bottke, W.F.:
Impact simulation in the gravity regime: Exploring the effects of parent body size and internal structure
2018, *Icarus*, **304** , 143-161

Bolin, B.T., Walsh, K.J., Morbidelli, A., Delbo, M.:
Initial velocity V-shapes of young asteroid families
2018, *Mon. Not. R. Astron. Soc.*, **473** , 3949-3968

Hanus, J., and 36 colleagues:
Spin states of asteroids in the Eos collisional family

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Budući rad

- Nove baze podataka: MOVIS-VISTA, GAIA, LSST
- Magnitude Size Distribution (V. Đošović)
- Izmena korisničkog interfejsa
- Sumarni podaci o familijama asteroida

HVALA NA PAŽNJI!