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Gaia spectroscopic view of asteroid collisional families: preliminary results

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The Gaia mission of the European Space Agency (ESA) was launched in December 2013 and began its scientific operations in July 2014. Gaia is essentially devoted to the measurement of positions, parallaxes, proper motions, brightnesses, and colours of stars. However, Gaia has also obtained astrometric, photometric, and spectroscopic measurements for several hundreds of thousands of asteroids.

The Gaia Data Release 3 (DR3) is the first to contain low resolution reflectance spectra of 60,518 solar system small bodies, the large majority of which are asteroids of the main belt (Gaia collaboration, Galluccio, Delbo et al. 2022). The global survey properties, the methods of data production and validation are detailed in the aforementioned paper published by the journal *Astronomy and Astrophysics*, which accompanies the DR3, and also summarised in the presentation of Galluccio et al. (2022) at this conference (EPSC 2022).

Here we present preliminary results about the Gaia view of asteroid collisional families. We identified asteroids belonging to families during the validation of Gaia asteroid spectra. Based on the family identification of Nesvorný et al. (2015), with the addition of the New Polana and the Eulalia families from Walsh et al. (2013), we found that in the Gaia DR3 there are 25,088 asteroids that belong to 116 collisional asteroid families of the 121 listed in Tab.1. This table also reports the number of family members and the number of members with a Gaia DR3 reflectance spectrum. However, the family identification of current catalogues is conservative by construction in order to keep good separation between the families. Hence, it is very likely that (i) some of the known families are more extended than what is available in current catalogues, namely, that catalogues based on dynamical criteria do not capture the whole extent of a family, and (ii) some unknown families are yet to be identified. This implies that the aforementioned number of asteroid family members with Gaia DR3 reflectance spectra is likely an estimation lower than the true number.

We will present some important features that Gaia observed in families. One of these is the correlation between some spectral parameters, such as the slope and the depth of the 1-micron

absorption band of the reflectance spectrum, and the age of members of asteroid families belonging to the so called spectroscopic S-complex (DeMeo et al. 2009). These correlations can be explained in terms of a space weathering process that reddens and reduces the 1-band depth as a function of time on S-complex asteroids.

For the brightest asteroids, the extension of Gaia reflectance spectra at wavelengths shorter than 0.45 micron is very useful for distinguishing the composition of primitive, carbonaceous asteroid families, which are difficult to be discriminated with the ground based spectroscopic data currently present in the literature.

References:

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Table 1: Number of asteroids with reflectance spectra, N_{DR3} , and number of asteroid members, N_{mem} , of known asteroid families. The family member identifier is from the catalog of Nesvorný et al. 2015. The membership of the New Polana and the Eulalia families are from Walsh et al. 2013.

Identifier	Name	N_{mem}	N_{DR3}
1	hilda	409	69
2	schubart	352	23
3	hungaria	2965	799
4	hector	12	1
5	eurybates	218	6
6	1996rj	7	1
8	arkesilaos	37	0
9	ennomos	30	7
10	2001uv209	13	1
401	vesta	15252	2717
402	flora	13786	2876
403	baptistina	2500	451
404	massalia	6424	197
405	nysa-polana	19073	1958
406	erigone	1776	142
407	clarissa	179	3
408	sulamitis	303	32
409	lucienne	142	14
410	euterpe	474	48
411	datura	6	1
412	lucascavin	3	0
413	klio	330	88
414	chimaera	108	18
415	chaldaea	132	40
416	svea	48	4
417	2001gb11	9	0
501	juno	1684	168
502	eunomia	5670	2118
504	nemesis	1302	53

Identifier	Name	N_{mem}	N_{DR3}
537	watsonia	99	39
538	jones	22	1
539	aeria	272	16
540	julia	33	1
541	postrema	108	21
601	hygiea	4854	500
602	themis	4782	1056
603	sylvia	255	25
604	meliboea	444	124
605	koronis	5949	1038
606	eos	9789	2243
607	emma	442	50
608	brasilia	579	64
609	veritas	1294	136
610	karin	541	19
611	naema	301	30
612	tirela	1395	228
613	lixiaohua	756	66
614	telramund	468	55
615	1993fy12	104	10
616	charis	808	23
617	theobalda	376	43
618	terentia	79	3
619	lau	56	1
620	beagle	148	24
621	koronis2	246	3
622	terpsichore	138	8
623	fringilla	134	32
624	durisen	27	5

505	adeona	2236	425
506	maria	2940	861
507	padua	1087	137
508	aeolia	296	8
509	chloris	424	88
510	misa	702	54
511	brangane	195	15
512	dora	1259	248
513	merxia	1215	83
514	agnia	2125	97
515	astrid	489	13
516	gefion	2547	633
517	konig	354	16
518	rafita	1295	203
519	hoffmeister	1819	71
520	iannini	150	19
521	kazuya	44	11
522	ino	463	70
523	emilkowalski	4	1
524	1992yc2	3	0
525	schulhof	5	3
526	2000by6	58	9
527	lorre	2	1
528	leonidas	135	30
529	vibilia	135	30
530	phaeo	146	27
531	mitidika	653	182
532	henan	1871	120
533	hanna	280	15
534	karma	124	14
535	witt	1816	60
536	xizang	275	14

625	yakovlev	67	9
626	sanmarcello	144	36
627	1998yb3	38	14
628	1999cg1	248	18
629	1999xt17	58	15
630	aegle	99	32
631	ursula	1466	292
632	elfriede	63	2
633	itha	54	28
634	inarradas	38	16
635	anfimov	58	7
636	marconia	34	4
637	2000uj87	64	0
638	croatia	161	12
639	imhilde	43	3
641	juliana	76	14
701	phocaea	1989	906
801	pallas	128	75
802	gallia	182	33
803	hansa	1094	306
804	gersuind	415	92
805	barcelona	306	79
806	tina	96	9
807	brucato	342	110
901	euphrosyne	2035	356
902	alauda	1294	507
903	ulla	26	5
904	luthera	163	24
905	armenia	40	2
-	new polana	2037	577
-	eulalia	1624	248

