Physical parameters of near-Earth objects from radar observations

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Asteroid-comet hazard

- Near-Earth objects (NEOs) – Objects of the Solar System (asteroids, comets) with the perihelion distances less than 1.3 astronomical units (AU).

  Population: >20 000

- Potentially hazardous objects (PHOs) – NEOs having a minimum orbital intersection distance with Earth of less than 0.05 AU (19.5 lunar distances) and an absolute magnitude of 22 or brighter.

  Population: >2 000

- Asteroid-comet hazard - The hazard of collision of the Earth with celestial bodies of asteroid, comet or artificial nature, usually NEOs.

Goals

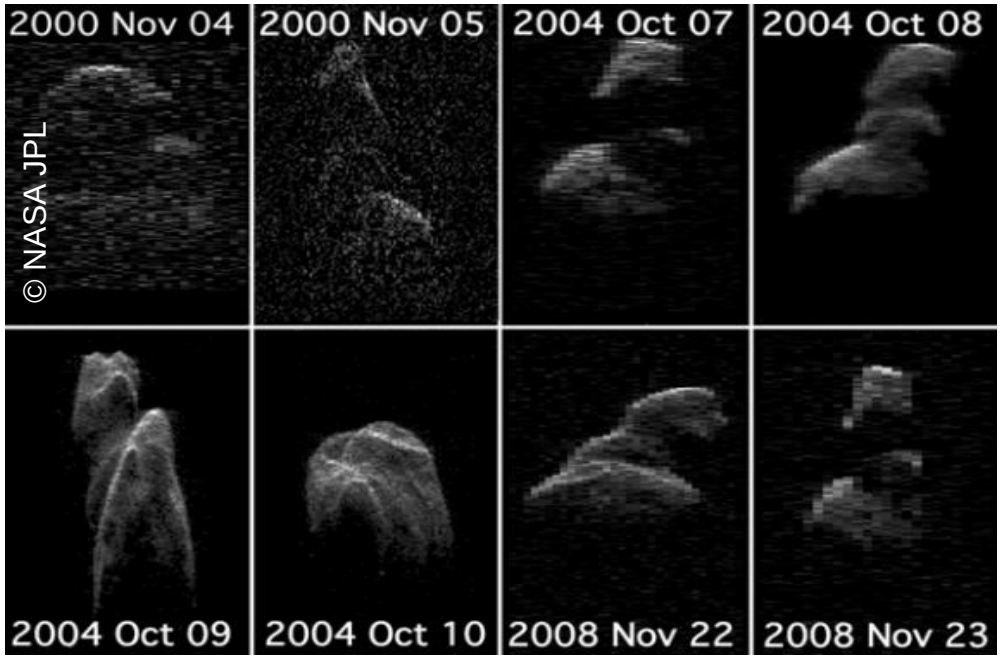
- Creation of advanced optical systems for detecting new NEOs that can scan the entire celestial sphere in a short period of time (Catalina, Linear, Pan-STARRS, LSST etc.);
- Organization of observation storage and processing centers, including identification of reliable orbits for newly discovered celestial bodies (MPC);
- Organization of monitoring programs for already known potentially hazardous NEOs to study their dynamic and physical evolution. (CNEOS, NOEDyS, NEOShield etc.);
- Development of fast and reliable algorithms for estimating the probability of NEOs impact with the Earth and the effects of such impacts, as well as proposals for eliminating the threat;
- Implementation of measures to eliminate the threat of NEO impact with the Earth or to reduce the scale of consequences.

Existing infrastructure

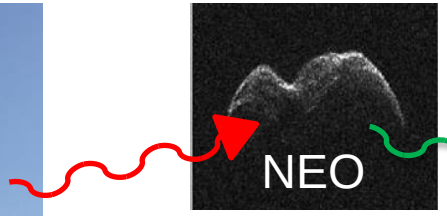
NEO monitoring (radio range)

Today, radar astronomy is one of the most effective techniques for determining the physical properties of near-Earth objects:

- Orbit determination accuracy (~1 m; ~1 mm/s);
- Physical properties of NEOs (size, shape, composition, rotation, surface...).



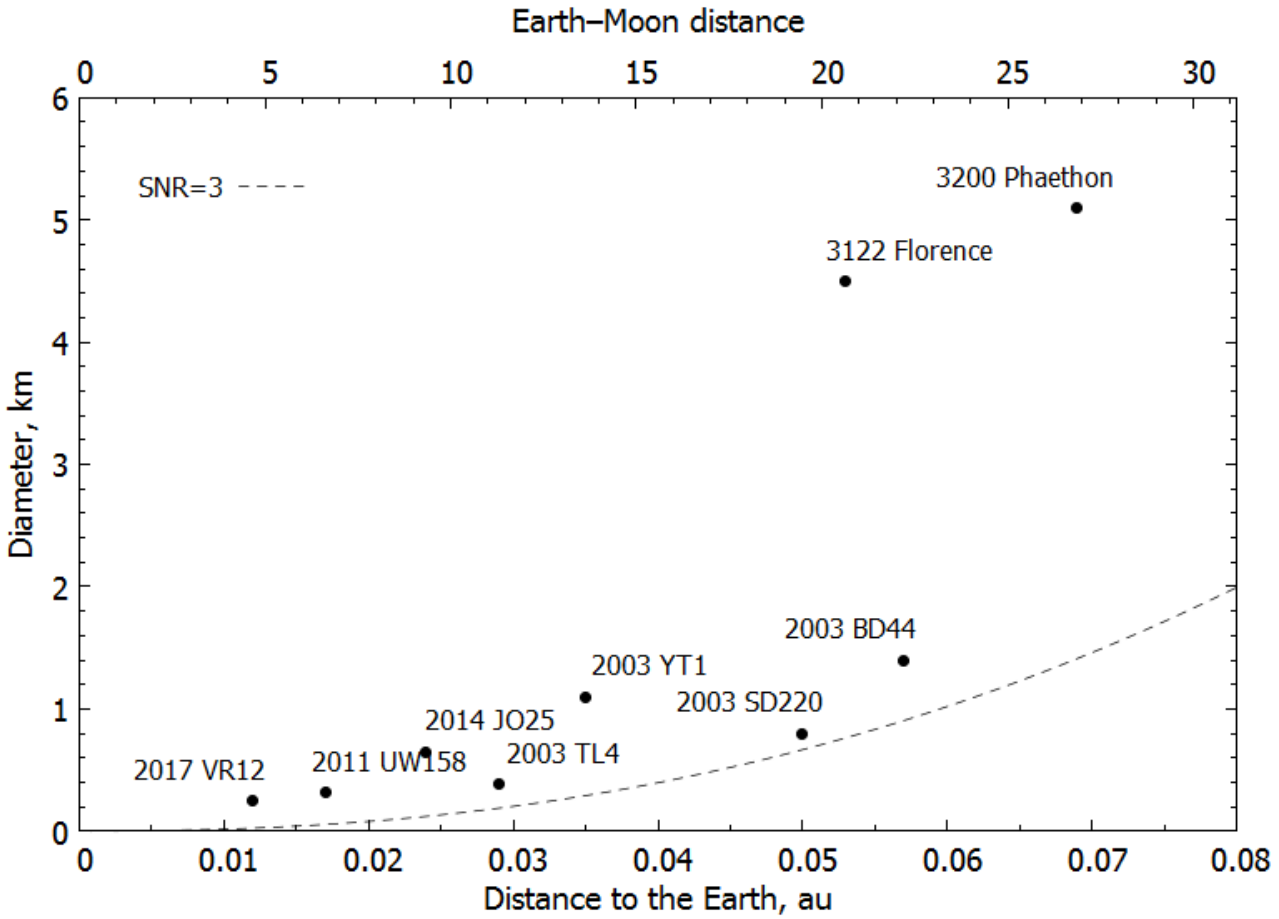
NEO monitoring (radio range)



- Institute of Applied Astronomy in cooperation with the Jet Propulsion Laboratory (JPL) and Goldstone Deep Space Communications Complex conduct intercontinental bistatic radar observations of NEOs;
- Echo signals from 8 potentially hazardous NEOs have been recorded: 2011 UW158, 2003 TL4, 2003 YT1, 2003 BD44, 2014 JO25, 3122 Florence, 2017 VR12 и 2003 SD220.

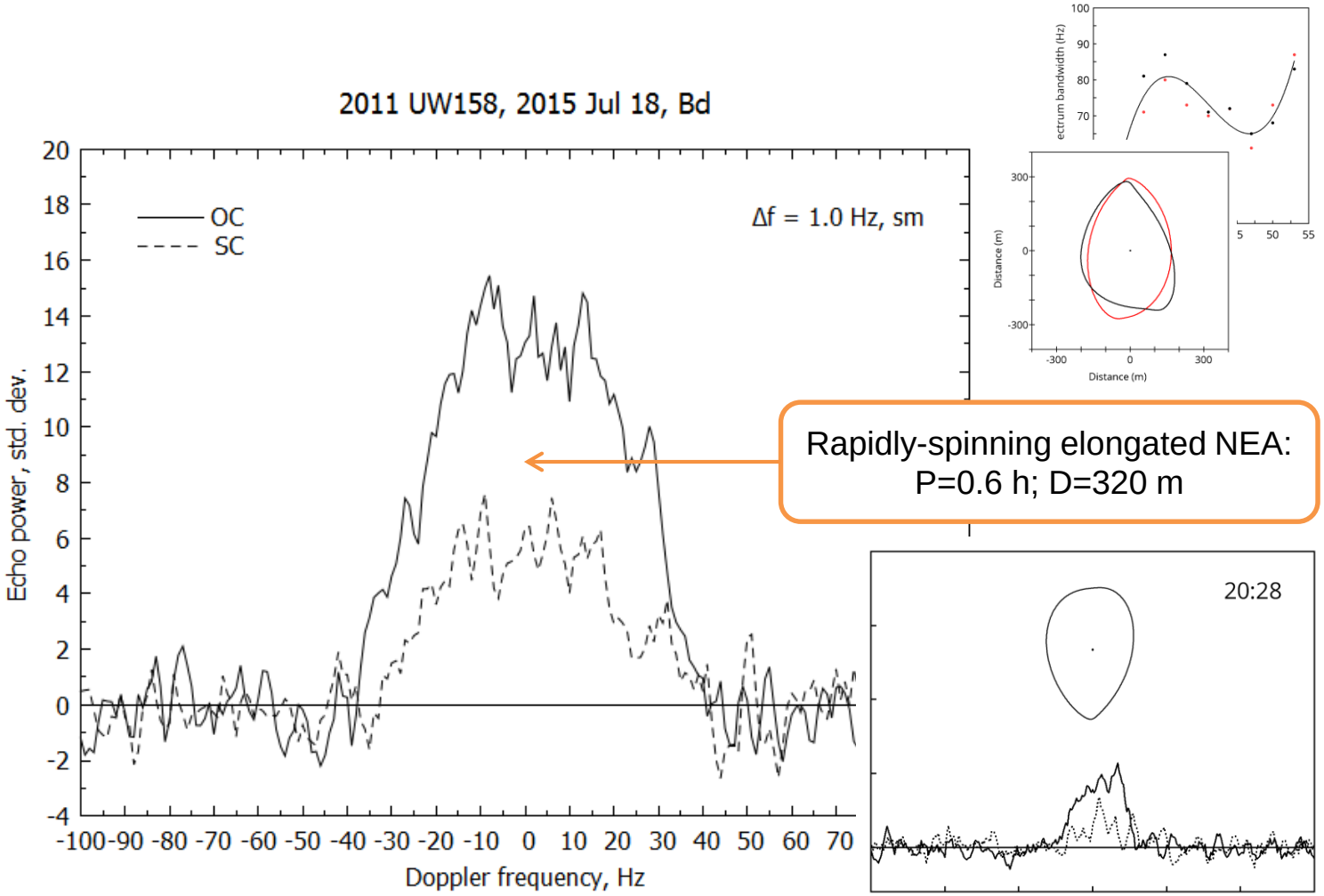
(see http://iaaras.ru/en/observations/echo/)

NEO monitoring (radio range)



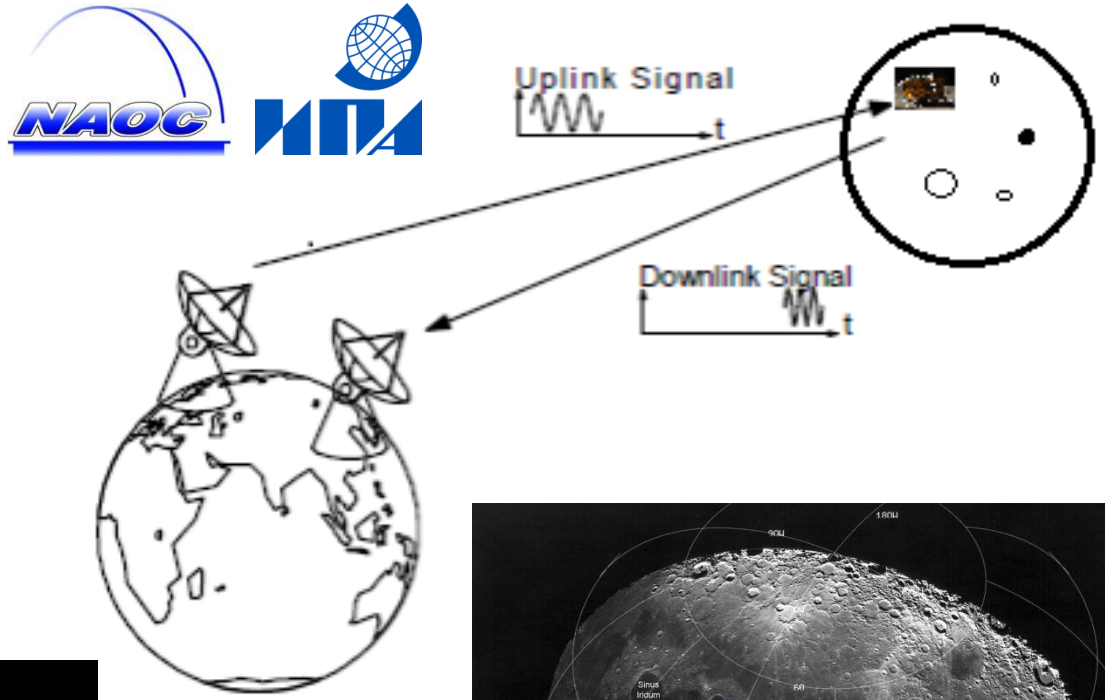
The size distribution of NEOs detected on RT-32, depending on the distance to the Earth.

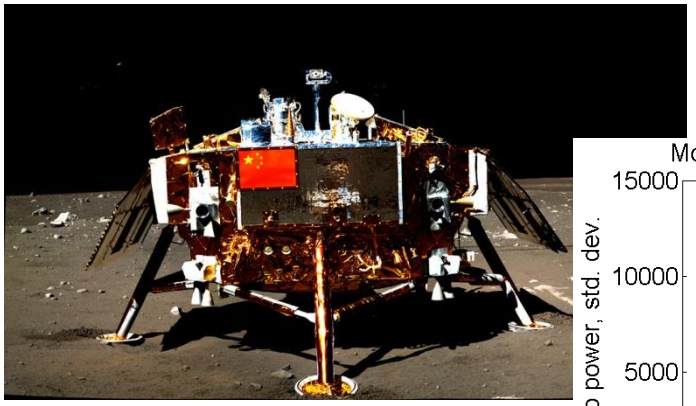
NEO monitoring (radio range)

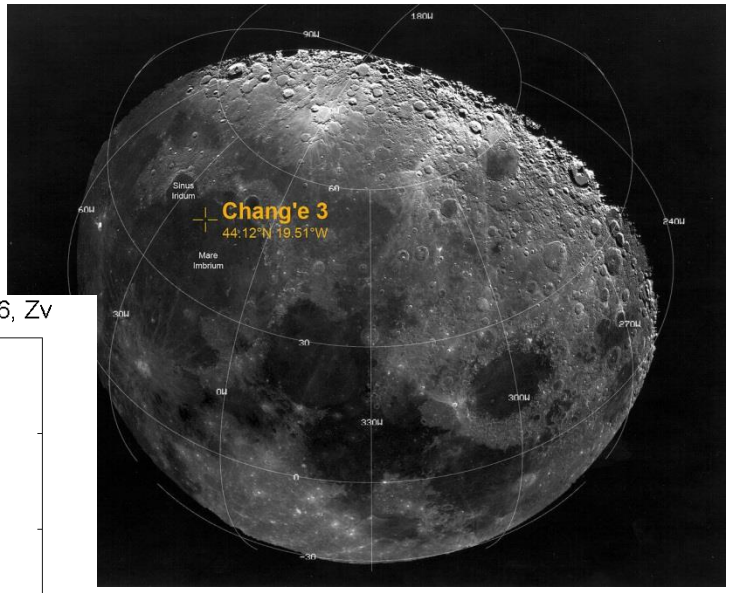


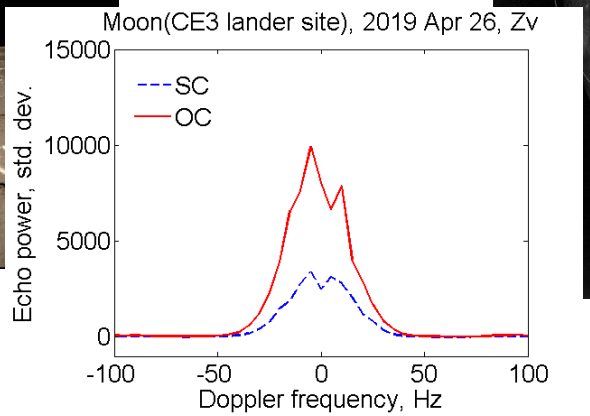
Echo power spectra of 2011 UW158 obtained from the joint DSS-14 and RT-32 observations on July 18, 2015 (~6.6 Earth-Moon distance).

Lunar monitoring (radio range)

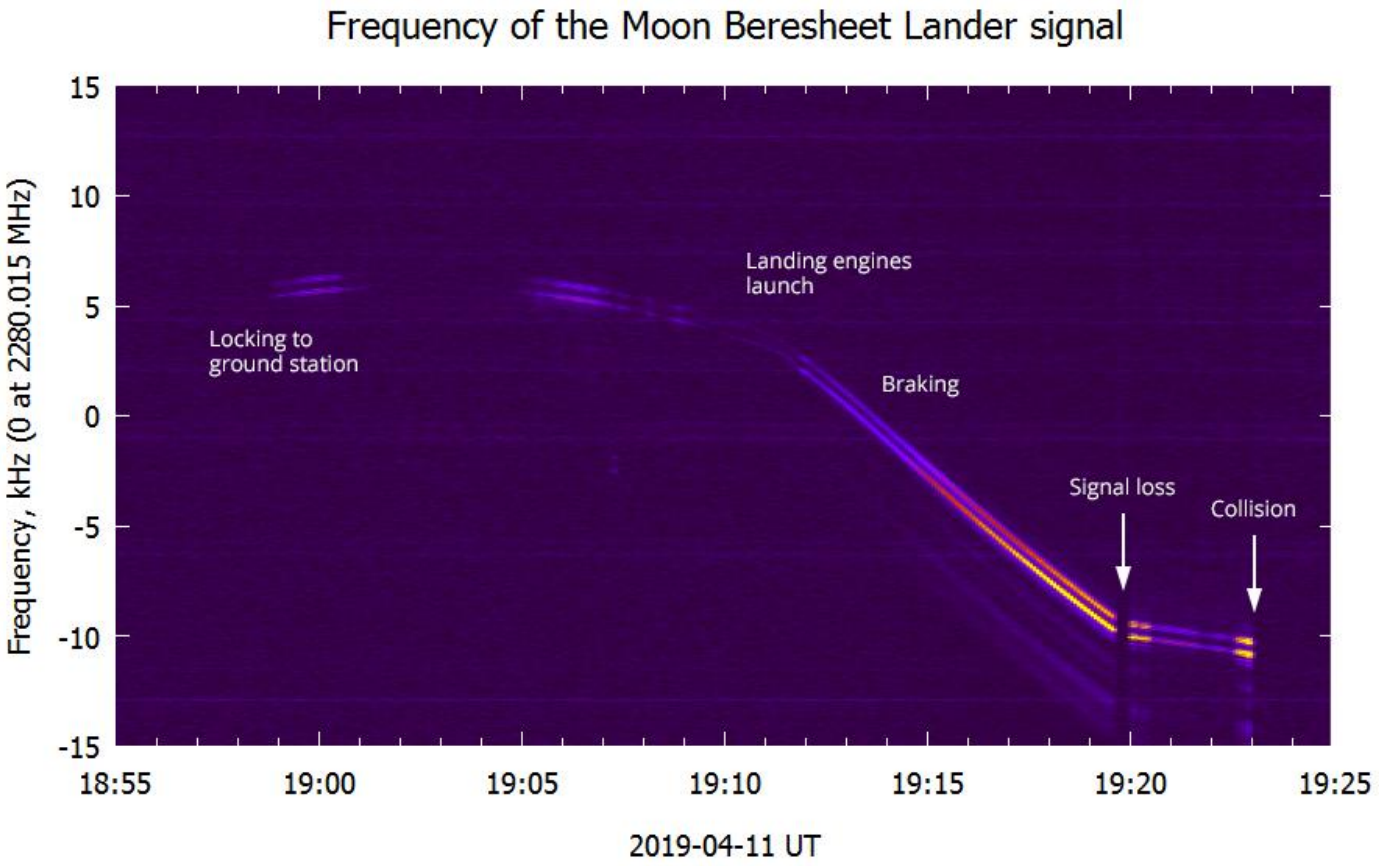








Spacecrafts and space debris monitoring (radio range)

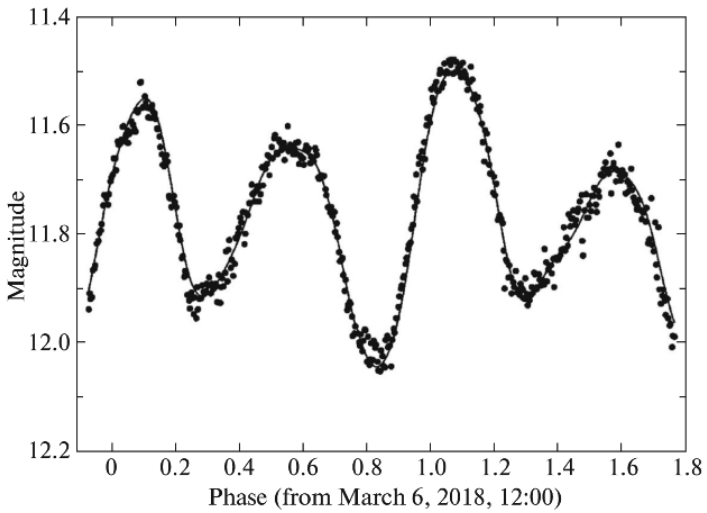


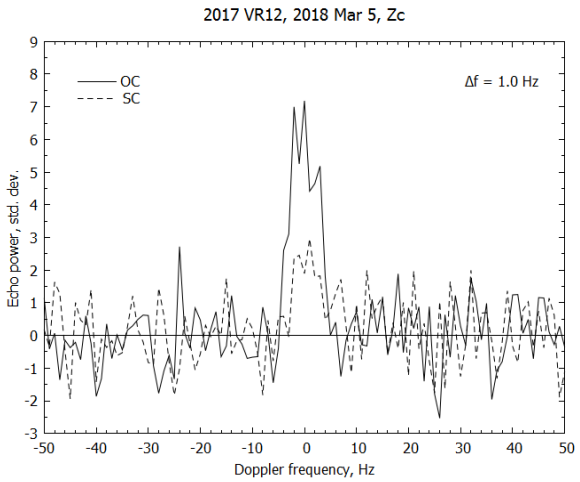
Spectrogram of Beresheet spacecraft signal obtained from observations of the RT-32 radio telescope on April 11, 2019.

NEO monitoring (optical range)

Positional and photometric observations of small bodies of the Solar system and artificial satellites.

Light curve and power spectra of 2017 VR12





Processing of observations and analysis of results

Таблица сближений астероидов с Землей и Луной

Дата и время обновления 20.01.2020 15:03

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Объект	Диаметр фотомет-рический (м)	С чем сближается	Дата сближения	Минимальное расстояние (в единицах расстояния Земля-Луна)	Относительная скорость (км/с)	MOID на дату сближения (в единицах расстояния Земля-Луна)	Вероятность столкновения	Энергия (Мт)	Палерм. шкала	Турин. шкала
2019 GJ4	12-65	Земля	2020 04 18.21121	43.22	4.13	2.10	0.00E+00	.44E-01	—	0
2019 JN2	14-67	Земля	2020 04 18.14406	67.91	4.82	1.12	0.00E+00	.79E-01	—	0
522684 (2016 JP)	128-539	Земля	2020 04 17.23323	36.52	10.23	11.61	0.00E+00	.22E+03	—	0
2019 KM2	15-69	Луна	2020 04 16.81613	114.03	11.26	9.10	0.00E+00	.50E+00	—	0
2010 JJ41	95-482	Земля	2020 04 16.66617	13.21	20.52	8.56	0.00E+00	.49E+03	—	0
2018 ER1	16-69	Луна	2020 04 16.65096	78.48	4.82	4.01	0.00E+00	.98E-01	—	0
522684 (2016 JP)	128-539	Луна	2020 04 16.61223	35.64	10.99	11.25	0.00E+00	.26E+03	—	0
2010 JJ41	95-482	Луна	2020 04 16.47401	12.64	21.34	8.65	0.00E+00	.53E+03	—	0
2007 HL4	27-124	Земля	2020 04 16.45695	15.95	3.88	12.60	0.00E+00	.34E+00	—	0
2019 GE1	7-33	Луна	2020 04 16.35309	35.17	2.90	3.23	0.00E+00	.37E-02	—	0
2012 EM8	23-102	Земля	2020 04 15.91679	19.97	3.66	15.16	0.00E+00	.18E+00	—	0
2018 KM	11-48	Земля	2020 04 15.68775	70.30	8.32	20.72	0.00E+00	.98E-01	—	0
2019 GJ	29-131	Земля	2020 04 15.41814	47.86	4.71	7.03	0.00E+00	.61E+00	—	0
2019 UN2	20-97	Луна	2020 04 14.96448	99.14	4.97	13.38	0.00E+00	.25E+00	—	0
2018 KM	11-48	Луна	2020 04 14.69630	69.37	7.42	25.93	0.00E+00	.78E-01	—	0
2019 UJ	9-40	Земля	2020 04 14.64548	114.04	11.68	6.96	0.00E+00	.11E+00	—	0
2019 GJ4	12-65	Луна	2020 04 14.30234	42.41	4.58	0.96	0.00E+00	.54E-01	—	0

"Forecast" software system identifies asteroids and comets that are potentially hazardous to the Earth
(see http://iaaras.ru/en/).

Conclusion

- The Institute of Applied Astronomy carries out observations of NEOs in the radio and optical ranges, individually and in cooperation with foreign observatories;

- The Institute is working on the determination and refinement of the orbits of the bodies of the solar system, including NEOs, developed and implemented original methods for estimating the probability and consequences of NEO collisions with the Earth;

- Full cycle of observation, processing and analysis of results is performed (see http://iaaras.ru/en/);

- Observational and computing infrastructure, as well as theoretical developments of the Institute of Applied Astronomy, are open for joint international research of Near-Earth objects.


Thank you for your attention!