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Prediction of Meteor Activities from (101955) Bennu

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The *OSIRIS-REx* spacecraft, currently orbiting near-Earth asteroid (101955) Bennu, has detected dust emission from the asteroid (Lauretta et al. 2019). Dust emissions from near-Earth asteroids and comets are responsible for most meteor activities at the Earth. Bennu has a Minimum Orbital Intersection Distance of only 0.003 au, comparable to many meteor shower parents. Here we present a preliminary calculation of the encounters between the recent ejecta from Bennu and the Earth.

The calculation is carried out using the meteoroid dynamics model described in Ye et al. (2016b). We are mostly interested in the ejecta released after 1500, as a preliminary simulation shows that the timescale for Bennu's ejecta to blend into the annual meteoroid stream is ~450 yr. We integrate the orbit of Bennu back to 1500, and then integrate it forward until 2100, with particles ejected at every perihelion following the ejection velocity calculated by the Whipple (1951) model. Gravitational perturbations from major planets (Mercury through Neptune, with the Earth–Moon system represented as a single particle at their barycenter) and radiative effects are included in the simulation. We assume the particles to be centimeter-sized following the initial report from (Lauretta et al. 2019), and assume a meteoroid bulk density of 2000 kg m^{-3}. We take Bennu's dust production rate to be 0.15 kg s^{-1}, the upper limit derived from the in situ observation of *OSIRIS-REx* (Hergenrother et al. 2019), though with a note that remote observation with the *Spitzer Space Telescope* indicated an upper limit that is 100$\times$ lower (Emery et al. 2014).

Encounters between 1900 and 2100 are summarized in Table 1. Our simulation shows that Bennu's ejecta are currently moving into Earth's orbit, with meteoroid flux increasing until the end of the simulation in 2100. Meteors from Bennu will radiate from approximately R.A. = 0^h20^m, decl. = −34° (in the constellation of Sculptor), with a geocentric speed of 6 km s^{-1}. The radiant is well placed in the night sky in the southern hemisphere. The very slow entry speed means that a 1 cm meteoroid will only produce a + 6 mag meteor (e.g., Ye et al. 2016a, Figure 1). At a dust production rate of 0.15 kg s^{-1}, the flux of these outbursts will be very low, with Zenith Hourly Rates of $\ll$1 for most years. Monitoring is however still encouraged, as unusual activity can point to elevated dust production at Bennu in the past a few centuries.

Table 1. A Summary of Meteor Outbursts from Bennu

Peak time (UT)	Total duration (hr)	Ejecta	Peak flux 10^{-6} km^{-2} hr^{-1}
1991 Sep 25 13:20	14	1500–1704	0.1
2014 Sep 25 09:47	10	1522–1711	0.1
2015 Sep 25 08:45	7	1505–1802	0.2
2018 Sep 25 08:01	8	1575–1877	0.1
2019 Sep 25 12:26	6	1523–1791	0.1
2021 Sep 24 21:16	11	1507–1682	0.2
2022 Sep 25 02:47	8	1508–1850	0.2
2025 Sep 24 23:20	8	1505–1802	0.3

2027 Sep 25 10:54	8	1514–1690	0.1
2028 Sep 24 12:19	9	1500–1884	0.3
2031 Sep 25 12:37	11	1500–1733	0.4
2032 Sep 24 18:19	10	1500–1869	0.5
2033 Sep 24 17:45	11	1511–1794	0.1
2034 Sep 25 00:26	11	1509–1875	0.2
2035 Sep 25 10:07	9	1500–1888	0.2
2036 Sep 24 15:08	9	1516–1797	0.2
2037 Sep 24 18:26	11	1515–1884	0.4
2038 Sep 25 03:54	9	1543–1790	0.3
2039 Sep 25 06:54	10	1502–1890	0.4
2040 Sep 24 11:51	9	1502–1717	0.3
2041 Sep 24 20:06	9	1513–1791	0.3
2042 Sep 25 03:21	10	1505–1885	0.7
2044 Sep 24 15:29	12	1500–1815	0.6
2045 Sep 24 17:53	11	1503–1888	0.9
2047 Sep 25 04:35	10	1507–1793	0.5
2048 Sep 24 12:31	11	1500–1892	10
2050 Sep 24 23:09	10	1502–1898	0.9
2051 Sep 25 04:06	12	1500–1874	1
2053 Sep 24 15:04	11	1502–1961	0.9
2054 Sep 24 20:51	11	1500–1879	0.6
2055 Sep 25 04:46	11	1503–1910	1
2056 Sep 24 08:13	9	1507–1898	2
2057 Sep 24 15:02	12	1505–1899	0.9
2058 Sep 24 20:31	12	1502–1903	0.8
2059 Sep 25 03:23	10	1502–1869	0.8
2060 Sep 24 09:14	12	1503–1858	1
2061 Sep 24 15:50	11	1500–1934	2
2062 Sep 24 20:48	11	1500–1894	2
2063 Sep 25 00:35	14	1500–1983	1
2064 Sep 24 08:58	10	1503–1962	1
2065 Sep 24 14:19	12	1502–1904	3
2066 Sep 24 18:43	10	1503–1881	0.4
2067 Sep 25 01:46	11	1500–1916	2
2068 Sep 24 11:02	8	1503–1821	2
2070 Sep 24 20:16	11	1500–1887	2
2071 Sep 25 00:55	12	1500–1954	5
2073 Sep 24 12:41	11	1500–1942	3

2074 Sep 24 18:07	11	1502–1964	6
2076 Sep 24 06:17	11	1500–1901	3
2077 Sep 24 11:00	11	1500–1984	4
2078 Sep 24 17:33	12	1500–1963	4
2079 Sep 24 23:38	11	1500–1991	4
2080 Sep 24 03:51	10	1500–1983	5
2081 Sep 24 11:00	10	1500–1968	4
2082 Sep 24 16:26	12	1503–1992	4
2083 Sep 24 22:35	11	1500–1954	4
2084 Sep 24 05:33	13	1500–1987	6
2085 Sep 24 09:58	11	1500–1992	7
2086 Sep 24 14:40	10	1500–1991	5
2087 Sep 24 21:54	12	1500–1967	4
2088 Sep 24 03:52	11	1500–1987	9
2089 Sep 24 10:36	12	1505–1991	1
2090 Sep 24 15:59	12	1500–1966	6
2091 Sep 24 20:48	11	1500–1997	16
2093 Sep 24 09:11	12	1500–2002	7
2094 Sep 24 14:10	12	1500–2073	15
2096 Sep 24 02:12	11	1500–2011	10
2097 Sep 24 06:54	10	1500–2066	21
2099 Sep 24 20:31	12	1500–2069	9

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Software: MERCURY (Chambers & Migliorini 1997).

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