A Bright Fireball Over The Coast of The State of Bahia

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ABSTRACT

In February, 21th around 01:27 (UT), inhabitants from the oceanfront cities of the states of Bahia, Sergipe and Alagoas observed a very bright fireball. Using four videos obtained with security cameras installed in metropolitan region of Salvador (Bahia) and in a car near Aracaju (Sergipe), it was possible determined the fireball trajectory and that it had a peak of absolute magnitude about -17, entering in the atmosphere with a velocity of 15.94 km/s, that was doing an angle of 49º (relative to the horizon). The fireball exploded at 21 km of altitude, about 134 km ESE from the coast of the city of Salvador. The energy released was estimated in 8.5 10^{-3} kt of TNT, corresponding to a pre-atmospheric mass between 700 kg and 1100 kg [1], being that the uncertainty obtained for this mass is caused by the imprecision in the measurement of the luminous flux in different recordings. Using the average density of an ordinary chondrite meteorite (3,8 g/cm³) [2], the most common meteorite type recovered in the Earth surface, the meteoroid diameter was estimated between 0.7 m and 0.85 m. Applying the D-criterion [3,4] in the estimate heliocentric orbit calculated for the meteoroid, we suggested that it was more probably a sporadic meteor.

INTRODUCTION

The growth of video cameras use has increased the number of brilliant meteor recorded in the world. This has also allowed an improvement of accuracy and precision in astrometry and in transit timing of these meteors. The recordings may or may not be made by equipments associated with projects dedicated to meteor monitoring [5]. These projects, in which BRAMON (Brazilian Meteor Observation Network) is included, have a network of cameras of higher sensibility that, with the aid of a dedicated software, are able to record the exact moment of meteor passages [6]. Yet, accidental records can happen in cameras not associated with any monitoring project like security and dash cams. On the night of February 21th, 2018, 01:27 UT, four cameras in the eastern Bahia and Sergipe states accidentally recorded a large meteor on the coast of the Bahia state (Figure 1).

Figure 1. Meteor as seen from Conceição do Coité (Bahia state) security camera.

Objective: Evaluate the atmospheric trajectory, heliocentric orbit and pre-atmospheric mass of the progenitor object of the meteor, and estimate the mass of meteorite fragments that reached the sea.

METHODS

❖ **Location:** Security cameras were in Salvador, Camaçari and Conceição do Coité, Bahia state, and a dash cam was installed in a car at the SE-100 road near Aracaju, Sergipe state (Figure 2).
❖ **Equipment:** Cameras with CCD of similar sensibility curves, quantum efficiency peak near 90% (around 650 nm) [7], a cutoff for wavelengths exceeding 750 nm, 30 frames/s rate, luminous fluxes about 0,1 lx, FOV of about 120 deg² (plate scale of hundreds of arcsec/pixel).
❖ **Analysis:** To obtain the atmospheric trajectory and the heliocentric orbit, it is necessary the ascension and declination of the beginning and end of the meteor trajectory and the transit time between these points. Coordinates were estimated using the plate scale and the equatorial coordinates of the FOV centers in each frame, which, in turn, were obtained from the approximate azimuth and height of the FOV centers inferred by information provided by the camera users. The videos were synchronized by comparison of the light curves of the meteor in each recording, using as a reference the curve of the Conceição do Coité video. Given the low sensitivity of the cameras, bright stars or planets were not recorded. Street lamps with constant brightness were used as reference for photometric calibration.

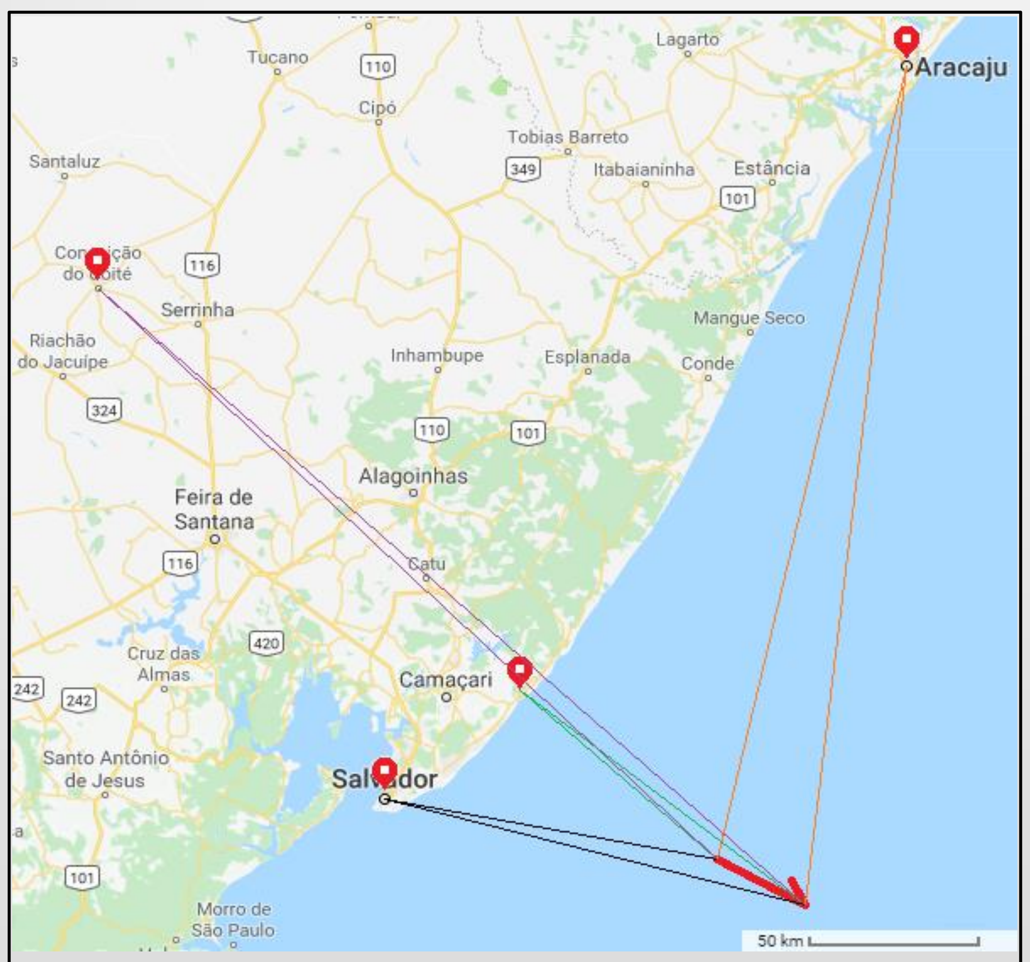

Figure 2. Position of each camera and the meteor.

RESULTS AND DISCUSSION

❖ **Photometry:** Based on the street lamps referential, the meteor reached a peak of average absolute magnitude equal to -17, with a relative percentage deviation of 20%.
❖ **Atmospheric trajectory:** The visible phase of the meteor captured by the cameras occurred between altitudes of 56 km and 21 km (relative to sea level), when it exploded 134 km ESE from the city of Salvador. The meteoroid had a pre-atmospheric velocity of 15.94 km/s, and had an angle of 49° relative to the horizon. This velocity implies that this meteor is prograde, having been captured by the terrestrial gravitational field.
❖ **Orbit:** The heliocentric orbit was estimated using the UFOOrbit® software [8] (Figure 3). This program has four levels (from Q0 to Q3) to evaluate the quality of the orbit. This orbit was classified as quality Q2, with orbital elements and pre-atmospheric velocity (Table 1) showing a relative percentage deviation of about 10%.

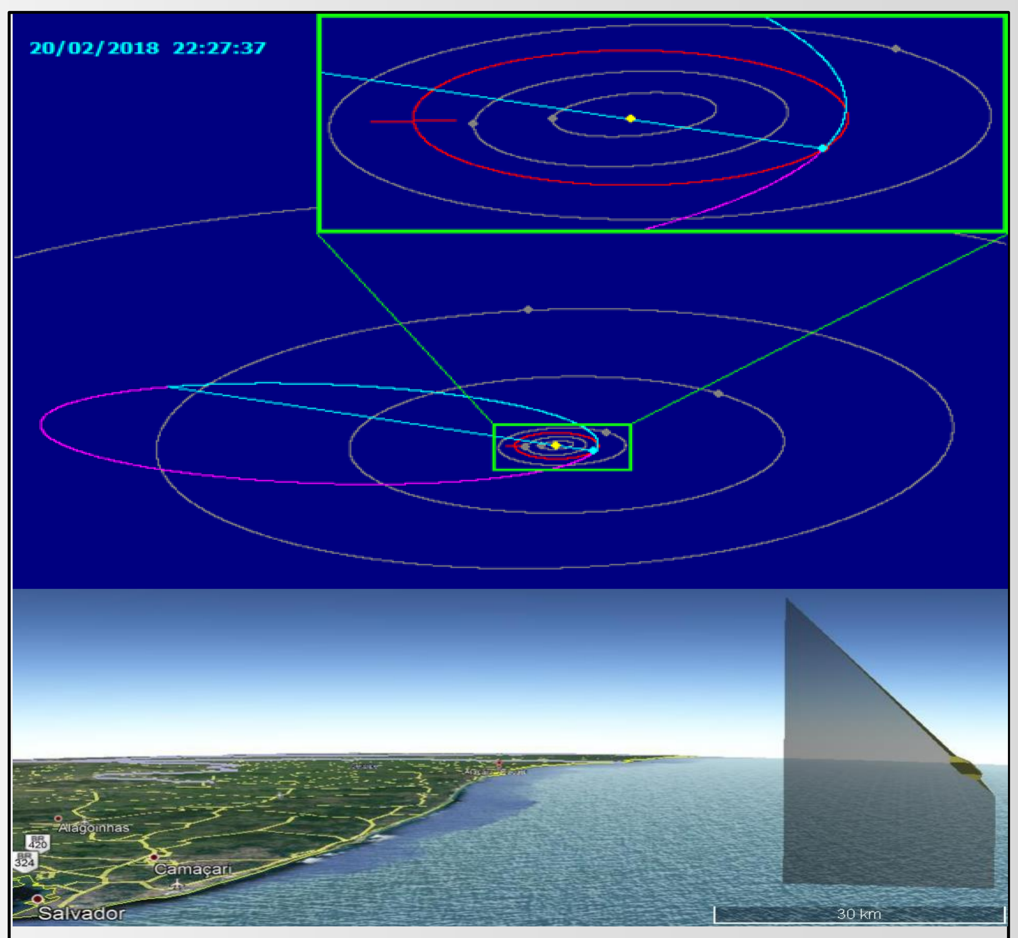

Figure 3. The orbit and trajectory of the meteor.

❖ **Light Curve, Pre-Atmospheric Mass and Diameter:** The total energy was estimated at 8.5 10^{-3} kt of TNT by the light curve of absolute magnitude [9] (Figure 4). Using the pre-atmospheric velocity, the mass of the meteor was 900 kg, with a deviation of 20% associated with uncertainties in the absolute magnitude. Applying the ablation model by Hawkins [10], it is estimated that about 4.2% of the pre-atmospheric mass reached the surface of the sea. Assuming the object with density of 3.8 g/cm³, similar to ordinary chondrite meteorites, type most often found on Earth, the mean diameter is 0.8 m.

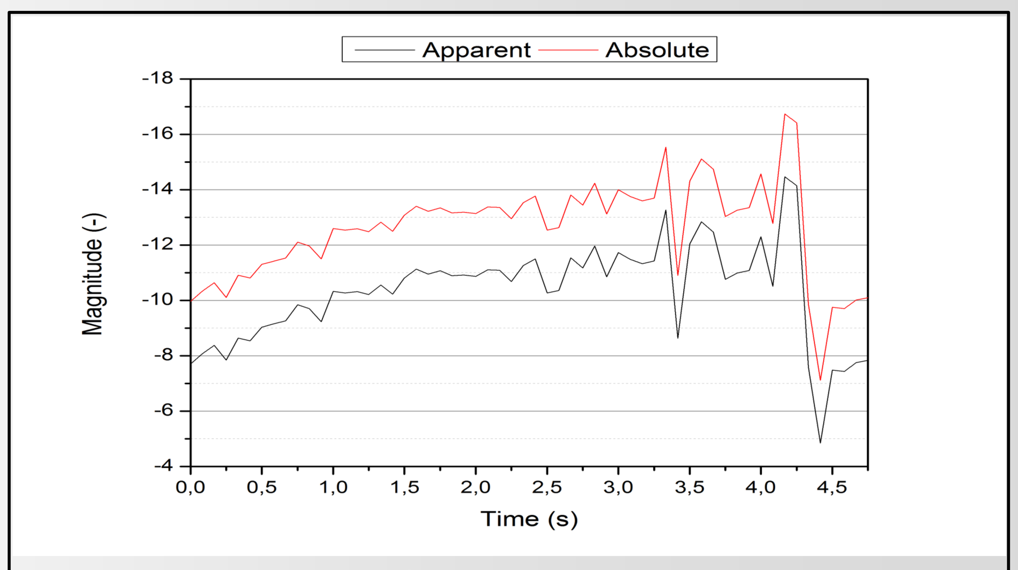

Figure 4. The meteor light curve.

❖ **Origin:** Using a variant of the orbital dissimilarity criterion of Drummond [11], it was marginally associated with the meteor shower β Cancrids (BCD) [12], thus been classified as a sporadic meteor. A video about the meteor analysis was uploaded on the BRAMON YouTube ® channel (Figure 5).

Table 1. Orbital elements of the meteor.

Elements	a [AU]	e [-]	i [°]	Ω [°]	ω [°]	ν [°]	P [years]
Values	6.8	0.856	2.3	152.1	15.2	293	17.56

CONCLUSIONS

1) The meteor was prograde, had an entry velocity of 15.71 km/s and a peak of absolute magnitude equal to -17, and made an angle of 49° relative to the horizon.
2) It was classified as sporadic meteor, but it can be slightly related with the BCD shower.
3) The pre-atmospheric mass was 900 kg (diameter of 0.8 m) and 4.2% of it may have reached the sea. The energy released as it entered the atmosphere was 8.5 10^{-3} kt of TNT.

Figure 5. Video analysis. Link: tinyurl.com/BolideBA

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