

# Atmospheric trajectory and orbit of the Osceola meteorite

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## Abstract

The aim of this study is to present a summary on the trajectory reconstruction, dark flight simulations and the Solar System orbit estimate for the day-light fireball widely observed over northern Florida (USA) on January 24, 2016 at 10:27 EST (15:27 UTC).

## 1. Introduction

Out of a total around 50,000 meteorites currently known to science, the atmospheric passage was recorded instrumentally in less than 0,1 % cases with the potential to derive their atmospheric trajectories and pre-impact heliocentric orbits. Similarly, while observations of meteors generate thousands of new entries per month to existing databases, it is extremely rare they lead to meteorite recovery [1].

We have conducted the detailed trajectory reconstruction, dark flight simulations and the pre-impact orbit estimate for the day-light Osceola fireball observed over northern Florida on January 24, 2016 at 10:27 EST.

The lower part of the atmospheric trajectory was retrieved from the weather radar indicating meteorite signatures shortly after the fall. The radar returns were strong, found at multiple altitudes and located on multiple stations: KJAX, KVAX and KTHL. There were also seismic recordings of the fireball which helped to specify, in particular, timing of the fireball.

## 2. The analysis of the luminous flight

A publicly available dash-cam video with the day-light fireball recording made by Erick Williams, was

carefully calibrated [2] and taken into account in reconstruction of the luminous part of the trajectory. The original dash-cam was kindly provided to us by the owner, so as to enable derivation of the exact camera properties and for star calibration. This facilitated the robust extraction of key characteristics of a meteoroid based on the available data.



Figure 1: One of the frames extracted from the dash-cam recording of the day-light Osceola fireball.

We have estimated dynamic meteoroid mass (and also the way it changes along the trajectory) using analysis of drag and mass-loss rate [3] derived from the observations. The data were treated thoroughly with account for the actual weather conditions at the time and location of the fireball [4]. The heliocentric orbit was derived using numerical integration of the equations of motion implemented in a software “Meteor Toolkit” [5, 1]. The Osceola has the most evolved orbit of all known L chondrites with orbits [6], with an aphelion sunward of the inner rim of the asteroid belt.

The derived values of the ballistic coefficient and mass loss parameter indicate [7, 8] that significant

part of the meteoroid's mass survived the atmospheric entry and reached the ground.

### 3. Details on the recovered Osceola fragments

Based on the weather radar data analysis Mike Hankey found the first meteorite fragment weighting 8.5 g on the eastern edge of the primary radar return on January 31, 2016. Within 2 hours Larry Atkins found the second 18.5 g fragment directly under the radar signature. In the following searches 6 more fragments of the meteorite were recovered with the masses of 5.5 g, 48.5 g, 839 g, 75.5 g, 90.5 g and 18.6 g.

The meteorite was classified as L6 ordinary chondrite.



Figure 2: The recovered 839 g fragment of the Osceola meteorite.

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