

REANALYSIS OF THE 24 NOVEMBER 1970 FIREBALL

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Introduction: In order to obtain Solar System orbits and atmospheric trajectory data for bright fireballs, photographic all-sky camera networks have been established around the globe. The goal of this study was to revisit presumed meteorite dropping fireballs photographed by German EN camera stations over Central Europe with particular emphasis on a bright fireball EN241170. This bright fireball was photographed during the night of November 23/24, 1970 above southern Germany. The fireball occurred at 01h 47m UT = 02h 47m MEZ [1, 2]. The event appeared to be a promising meteorite dropper and the EN records of this fireball were timely reduced by Zdeněk Ceplecha at the Ondřejov Observatory [1]. The possible meteorite fall EN241170 received the provisional name “Mount Riffler” [1]. However, given the shallow entry of the fireball with large associated area of the probable meteorite fall, as well as not a favorable for the search mountain terrain around the Mount Riffler in the Austrian Alps, no systematic field campaign was ever undertaken in the EN241170 case [2].

Meteorite recovery of June 1976: A single 724 g stony meteorite covered with a fresh fusion crust was occasionally found on a mountain road near Ischgl (Tyrol, Austria) ~13.8 km in SW direction from the predicted impact site in June 1976. The meteorite was not studied or identified until 2008 when it was finally given to scientists. The LL6 chondrite has a weathering grade W0 implying very recent time of the fall. The meteorite got its official name Ischgl from the closest Austrian town [3]. The Ischgl meteorite is listed as a find and not as an observed fall. However, it is unlikely, that there are two meteorite falls occurring this close to each other both, geographically and in time. Besides, since German EN camera stations were in continuous operation, all potential meteorite dropping events were revisited.

Methods: To answer the question if the Ischgl meteorite was from the 24 November 1970 fireball, we investigate if the EN241170 fireball could drop meteorite fragments in the area where the Ischgl meteorite was reported to be found. To do that we first thoroughly retrieve the trajectory of the EN241170 fireball using the FireOwl software used by the Finnish Fireball Network. The recalculated trajectory allows us to run state-of-the-art Monte Carlo (DFMC) simulations that reproduce both luminous and dark flight in great detail and produce a meteorite strewn field as an outcome [4].

Results and Discussion: The recalculated trajectory is close to the trajectory calculated in 1977 and with certain start point parameters we got a nominal mass very close to the earlier predicted impact site [1]. Moreover, accounting for the direction of the trajectory, the 1977 predicted impact point is consistent with the found location of the Ischgl meteorite as well. While the line connecting these two locations appears parallel to the direction of our DFMC modelled strewn field.

Further simulations show that the find location of the Ischgl meteorite is well inside the predicted strewn field of our DFMC model for 24 November 1970 fireball. Our model also gives similar sized fragments in the recovery area. The projection of our recalculated trajectory is situated only 1.1 km from the recovery site. This difference is well within the error margins of known variables such as atmospheric winds and effect of the meteorite shape [4]. Besides, the meteorite was found on the terrain elevated about 2000 meters above sea level in high mountains where wind conditions used in the simulations are not very well constrained.

Conclusions: Our study shows with high certainty that the 24 November 1970 fireball was indeed the fall event of the Ischgl meteorite. We recommend that the Ischgl meteorite should be listed as a confirmed meteorite fall [5] as its recovery vs calculated strewn field position provides the match as good as any other case from the list of meteorites with photographic orbits [6]. Subsequently it should also be added to the list of meteorites with known heliocentric orbit in the Solar System as a 3rd ever documented in the history case preceded by Pribram and Lost City.

References: [1] Ceplecha Z. (1977) *Publishing House of the Czechoslovak Academy of Sciences*, Vol. 28, No. 6, p. 328-340. [2] Oberst J. et al. (1998). *Meteoritics & Planetary Science* 33:49-56. [3] *The Meteoritical Bulletin Database*, accessed 2 May 2021. [4] Moilanen J. et al. (2021) *Monthly Notices of the Royal Astronomical Society*, 503:3, 3337-3350. [5] Agee C. et al. (2015) *The Meteoritical Bulletin*, 24 Feb 2015. [6] <https://www.meteoriteorbits.info/>