WIDE-FIELD IMAGING OF HALLEY'S COMET DURING 1985-1986 USING SCHMIDT-TYPE TELESCOPES

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ABSTRACT

Photographic imaging of the plasma- and dust-tails of bright comets requires fast (f<4.0), wide-field (FOV>5°) optics for the proper recording of these large, low surface brightness features. Schmidts and astrographs are well-suited to this task and a large number of these instruments around the world will be turned toward Halley's Comet in 1985-1986 in support of the Large-Scale Phenomena Discipline of the International Halley Watch (IHW). This "worldwide network" should provide imagery with a time resolution never before realized in the study of a comet, and major breakthroughs in the understanding of highly-variable, elusive plasma processes in comets are expected. The imagery will also provide support for the GIOTTO, VEGA, AND PLANET-A deep space probes to the comet.

1. THE NEED FOR A WIDE-FIELD NETWORK TO STUDY HALLEY'S COMET

The rapid variability of cometary plasma tails, and the associated need for high-time resolution imagery, have been known since the regular application of photography to the study of these tail systems began in the 1890's. A full review of the subject is not possible here, but it is important to note that E. E. Barnard in 1905 (Barnard 1905) advocated that wide-field photographs of bright comets be taken as often as possible--preferably every half hour--in order that the rapid changes at times of high cometary activity could be studied effectively. Such time resolution has not, unfortunately, come close to being realized in any past comet, due almost entirely to the short observation times at individual sites (1-2 hours typically) and to the lack of coordination among observers around the world.

Many of the tail disturbances noticed by Barnard and his contemporaries are now known to be disconnection events, or DE's, in which the entire plasma tail uproots itself from the head of the comet, drifts away in the anti-solar direction, and is replaced by a new plasma

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 233–235.

https://doi.org/10.1017/S0252921100106645 Published online by Cambridge University Press

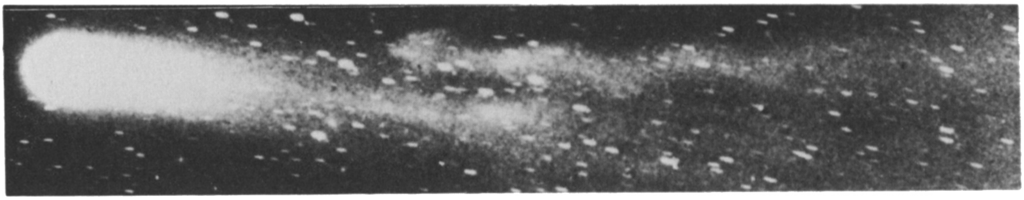

Fig. 1: Yerkes Observatory photograph of Halley's Comet on 1910 June 6 showing a Disconnection Event in the plasma tail.

tail. An example of a DE in Halley's Comet in 1910 is shown in Fig. 1. Another class of plasma-tail transient is helical wave structure, an example of which is shown in comet Kohoutek 1973XII in Fig. 2. The physical causes of DE's and helices are thought to be magnetic reconnection at interplanetary sector boundary crossings (Niedner and Brandt 1978, 1979; Niedner, Ionson, and Brandt 1981) and the Kelvin-Helmholtz instability (Ershkovich 1979), respectively.

The time-scales associated with DE's and helical waves are short. Although the persistance times of detached tails can be several days, recession speeds from the cometary head are large enough--50-200 km s^{-1} (Niedner 1981)--that an accurate kinematical description might require 30 or more images spanning each DE (never before achieved); hence, the need for near-hourly images. Moreover, high-time-resolution imagery is necessary to ascertain the onset time of the DE, a parameter of importance when attempting to find a correlation with solar-wind events. DE's typically occur every 1-2 weeks. The actual growth of helical waves has never been observed in a comet tail, and the inference is that the growth time must be << 1 hr. As pointed out by many workers, knowledge of this time-scale is critical to our understanding of these waves. Despite the knowledge gained in recent years from a re-examination of historical data, much remains to be done on a bright comet which exhibits the full array of large-scale phenomena and whose arrival time is known. Only Halley's Comet meets these requirements.

2. THE LARGE-SCALE PHENOMENA DISCIPLINE OF THE IHW

The International Halley Watch (IHW) is well-known to most astronomers around the world. It has formally been endorsed by the IAU

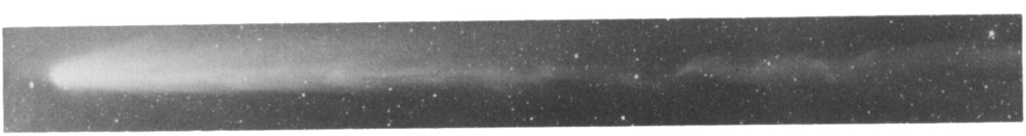

Fig. 2: Helical waves in comet Kohoutek's plasma tail (JOCR)

https://doi.org/10.1017/S0252921100106645 Published online by Cambridge University Press

at the 1982 meeting (in Patras, Greece), and it will almost certainly be the major ground-based effort directed at Halley's Comet. The purpose of the IHW is to encourage the observation of Halley around the world, to help guide the observations when necessary (or when asked), and to collect as much of the data as possible for inclusion in a permanent Halley Archive. Large-Scale Phenomena, one of seven IHW Disciplines, is administered by Discipline Specialist John C. Brandt. The goals of this Discipline are to assemble a uniquely complete set of imagery to advance the study of rapid plasma-tail disturbances, and to support the deep space comet missions by providing data on the state of the "entire comet" at the times of the encounters. The photometric effort of the Discipline is described in detail in this volume by D. A. Klinglesmith.

As a result of several calls for worldwide support, the Large-Scale Phenomena Network presently consists of ~75 facilities around the world, the majority of which are Schmidt cameras and astrographs, but also included are patrol cameras, Celestron-class Schmidts, and 35mm cameras. Given the basic goal of hourly coverage, the present network is in good condition although additional facilities are always vital (and welcome) as contingencies against poor weather, etc. A source of large concern is the understandable paucity of observatories in the Southern hemisphere: in 1986 March, the time of greatest scientific interest, Halley will primarily be a S. hemisphere object. Funds permitting, expeditions equipped with Celestron Schmidts to remote islands are not out of the question.

Wide-field observational techniques--including exposure times, emulsions, and filters--have been discussed elsewhere (Niedner, Rahe, and Brandt 1982). They are meant to be guidelines and suggestions, and are by no means rigid "instructions". The Large-Scale Phenomena Discipline Specialist Team sends out circulars several times each year and one of the issues planned for 1984 will discuss observational techniques in more detail. Individuals not already in the network or on our mailing list, but who wish to be, should contact J. C. Brandt or M. B. Niedner (Code 680, NASA/GSFC, Greenbelt, MD 20771, USA), or J. Rahe (Remeis Sternwarte, Universität Erlangen-Nürnberg, Bamberg, FRG).

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