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RADAR METEOR ORBITAL STRUCTURE OF SOUTHERN HEMISPHERE COMETARY DUST STREAMS

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The Christchurch, New Zealand meteor orbit radar (AMOR) with its high precision and sensitivity, permits studies of the orbital fine structure of cometary streams. PC generated graphics are presented of data on some Southern Hemisphere Streams. Such data can be related to the formation phase and subsequent dynamical processes of dust streams.

INTRODUCTION

The AMOR 8 km baseline facility has been in routine operation since April 1990 and to June 1991 1.32 x 10^5 meteoroid orbits have been obtained. The limiting sensitivity corresponds to radar meteor magnitude + 13 with orbital precision 2 degrees in angular elements and 10% in (1/a,) (Baggaley et al 1992).

An outstanding feature of the facility is the radar signal processing routines and orbit reduction and graphics packages which permit rapid presentation and analyses of a large number of orbits. Such comprehensive data sets will permit the study of the structure and related dynamics of cometary dust streams. The orbital properties of four short-period cometary streams observed in 1990-1 are here presented for the Eta Aquarids, Alpha Scorpids, South delta Aquarids, Alpha Capricornids. AMOR achieves a high data rate: for example the number of high precision orbits for the Eta Aquarids, is 361, compared with the 5 of Lindblad (1989) and 1 of Cook (1972).

THE DATA

We have several methods of analysing and presenting data. For illustration two types of presentation are given. Right ascension - declination plots (40° x 14°) of meteor radiant points of (i) all meteors and (ii) those meteors identified as cometary stream members by employing the modified D criterion of Drummond (1979). The DD criterion gives a measure of the distance between points in a five parameter orbit phase space. The procedure was a serial search employing a seed orbit (from Cook 1972 or a mean from an AMOR direct D test) and subsequent membership requiring at least two orbits with DD < 0.04. The other presentation is of the orbital distributions and mean values of those meteors selected from the serial search.

Work has also been carried out on the density profiles of streams: achieved by fixing four elements while varying the fifth across the range of interest.

Examples of the PC-generated graphics available from the AMOR system are shown in Fig 1 giving celestial coordinate plots of corrected meteor radiants for the Eta Aquarid shower 1990 and Fig 2 showing distributions of orbital elements for the Southern Delta Aquarid shower 1990. Fig 1 illustrates the daily radiant motion (L being the solar longitude) and stream member selection resulting from the operation of the DD criterion. From the

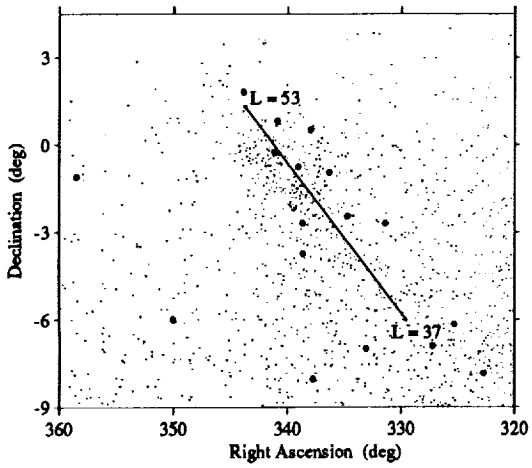

Figure 1(a): Daily motion of the eta Aquarid mean orbit is overlaid on the corrected geocentric radiants 1990 April 28 - May 18. L is the solar longitude. Large dots correspond to to meteors brighter than +5 mag.

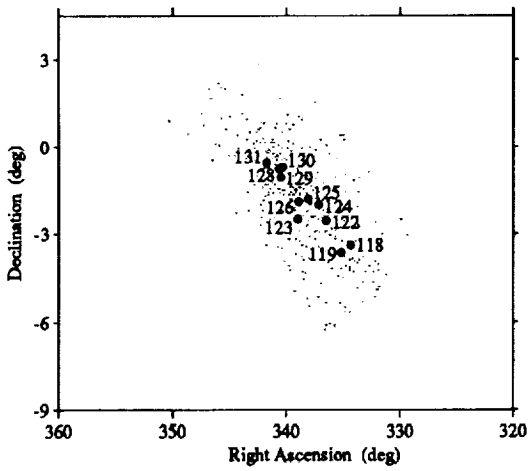

Figure 1(b): Mean position of the radiant points for shower meteors detected on each day number as the Earth moves through the stream.

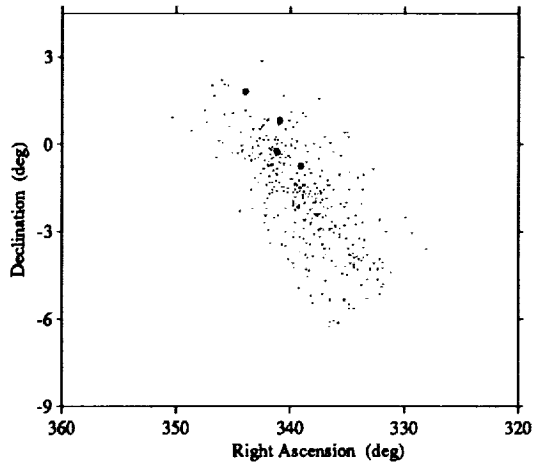

Figure 1(c): Radiants of 361 meteors selected by a RA-Dec box parallel to the daily motion of the radiant.

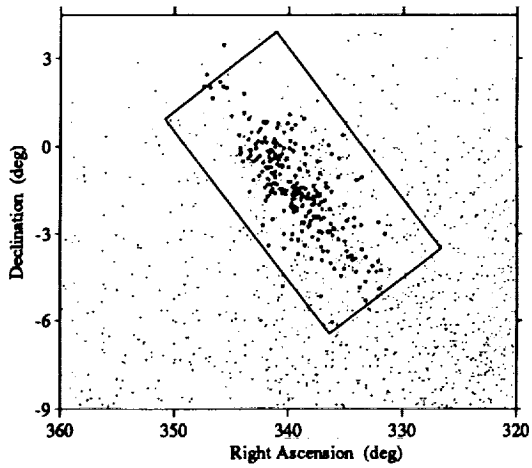

Figure 1(d): Radiants of stream meteors identified using a D criterion serial search plotted as larger spots. The mean stream orbit from (c)is used to seed the group and membership requires two parent sponsors within DD < 0.04 of the proposed orbit.

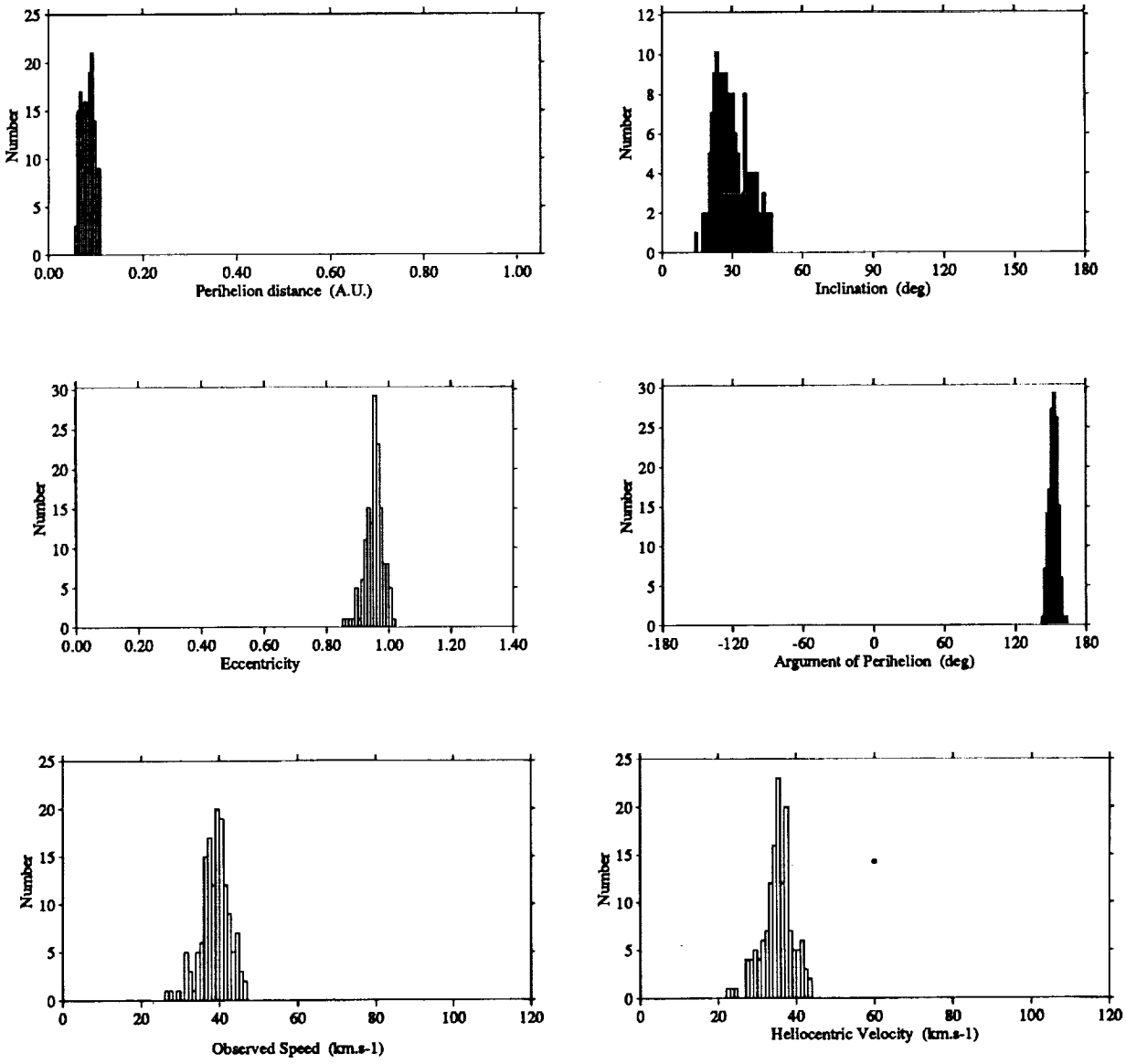

Figure 2: Southern Delta Aquarids. Distribution of orbital elements for 144 stream meteors detected 1990 August 3,4 and 5.

TABLE 1. MEAN ORBITAL ELEMENTS

Stream	Dates	Number	q	e	i	ω	Ω_{1950}
Eta Aquarids	1990						
radiant box	April 28-May 18	361	0.566	0.969	165.8	95.4	45.8
			±0.006	±0.009	± 0.1	± 0.9	± 0.2
serial search		270	0.555	0.983	165.5	94.5	45.5
			0.004	0.008	0.1	0.7	0.2
L = 49		65	0.535	0.972	165.6	91.7	44.6
			0.009	0.017	0.1	1.5	0.2
L = 45		61	0.575	1.013	165.5	97.8	48.1
			0.007	0.015	0.1	1.1	0.2
Alpha Scorpids	1991						
L = 38°	April 27-9	53	0.22	0.81	4.5	130.0	218.0
			0.01	0.01	0.05	2.0	
L = 46°	May 7-9	38	0.20	0.85	3.0	136.0	226.0
			0.01	0.01	0.05	2.0	
Southern Delta Aquarids	1990						
L = 119°	July 21-3	152	0.060	0.95	29.5	156.0	299.0
			0.005	0.01	1.0	0.3	
L = 139°	Aug 3-5	139	0.117	0.96	24.6	152.0	319.0
			0.005	0.01	1.0	0.3	
Alpha Capricornids	1990	57	0.583	0.70	7.0	266.0	127.0
	Aug 1-3		0.06	0.01	1.0	2.0	

analysis of such distributions shown in Fig 2 orbit elements with associated standard errors in the means (s.e.) can be derived. The results are shown in Table 1 for the four streams. Three of them show evidence of two distinct components; substreams with significantly different orbits, revealed as the earth moves through the general dust stream. Because of the high data data rate achieved by AMOR such structure in streams and the form of the distribution of orbital elements can be studied. Such features can then be related to orbital changes of the parent comet and to dust dispersal mechanisms.

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