Evolution of Halley's Comet & Orionid Stream

(Supervised by Dr David Asher)

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Plan of Talk

1. Brief Introduction- Relevant Existing Works on Comet Halley & Resonance of Orionid Stream

2. Initial Results

3. The Final Goal

1. <u>Relevant Existing Works:</u>

1.1. Long Term Evolution and Life Time of Comet Halley

* Observational records date back to 240 B.C. (Yeomans & Kiang 1981)

* Accurate orbital calculations are available from 1404 B.C. (Yeomans & Kiang 1981)

* Comet Halley's dynamical lifetime is estimated of the order of 100,000 years (Hughes 1985, Hadjuk 1986, Steel 1987, Emel'yanenko & Bailey 1996)

Photograph of Comet Halley (Source: W. Liller, IHW, 8 March 1986)

ESA's Giotto Image of Comet Halley

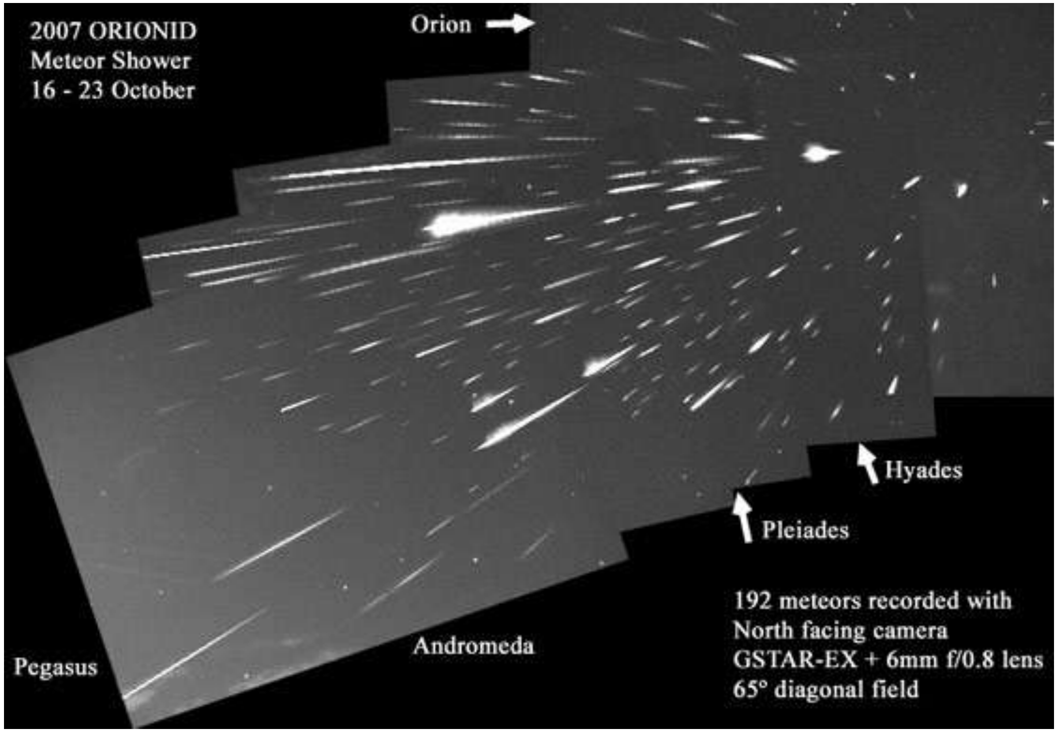
1.2. Resonance of Orionid Stream

* Peaking of Orionids in 2006 was unexpected

* Rendtel proposed 1:6 resonance as a mechanism (Rendtel 2007), noting also enhanced Orionid rates between 1933-1938 (Lovell 1954)

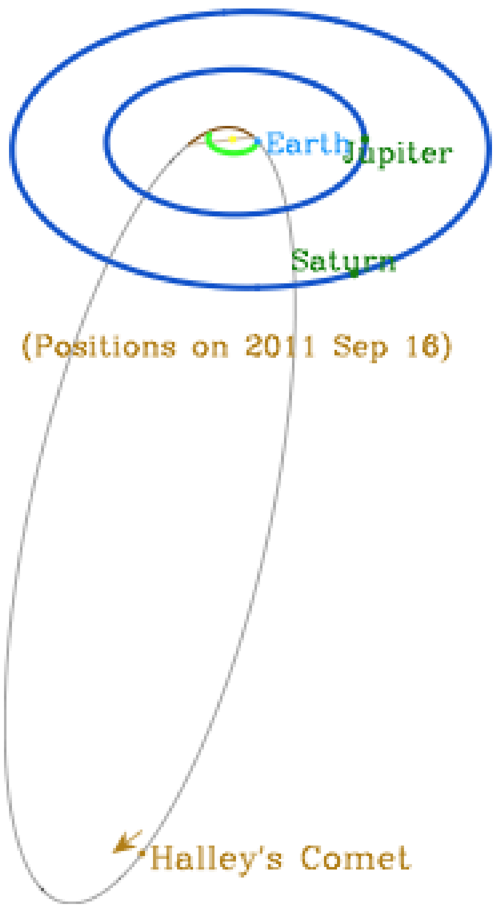
* It was also found that streams ejected in -1,265, -1,197 and -910 approached Earth in 2006 (Sato & Watanabe 2007)

(Source: Astron.Assoc.Queensland)



Engraving of 1833 Leonids Storm

- Orbit of Comet Halley as of 16 Sep 2011



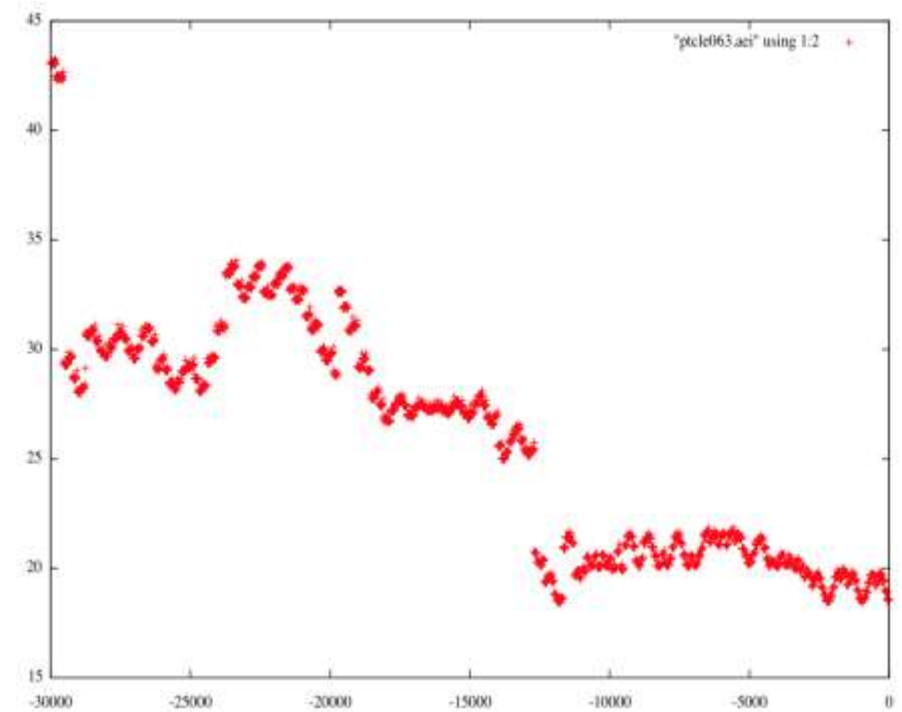
2. <u>Initial Results</u>

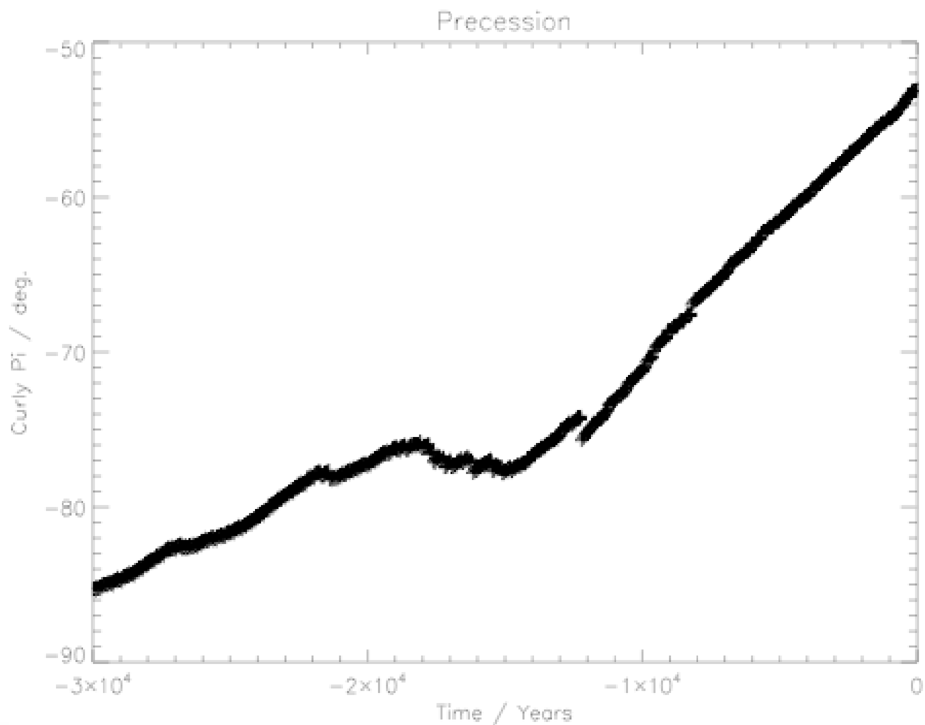
2.1. Comet Halley's Present Orbit

* Backward integration for 30,000 years was done for 100 test particles

* Longitude of pericentre (measure of precession of orbit) shows a significant variation (and also a discontinuity in many cases)

Semi-Major Axis (AU) Vs Time (Years)



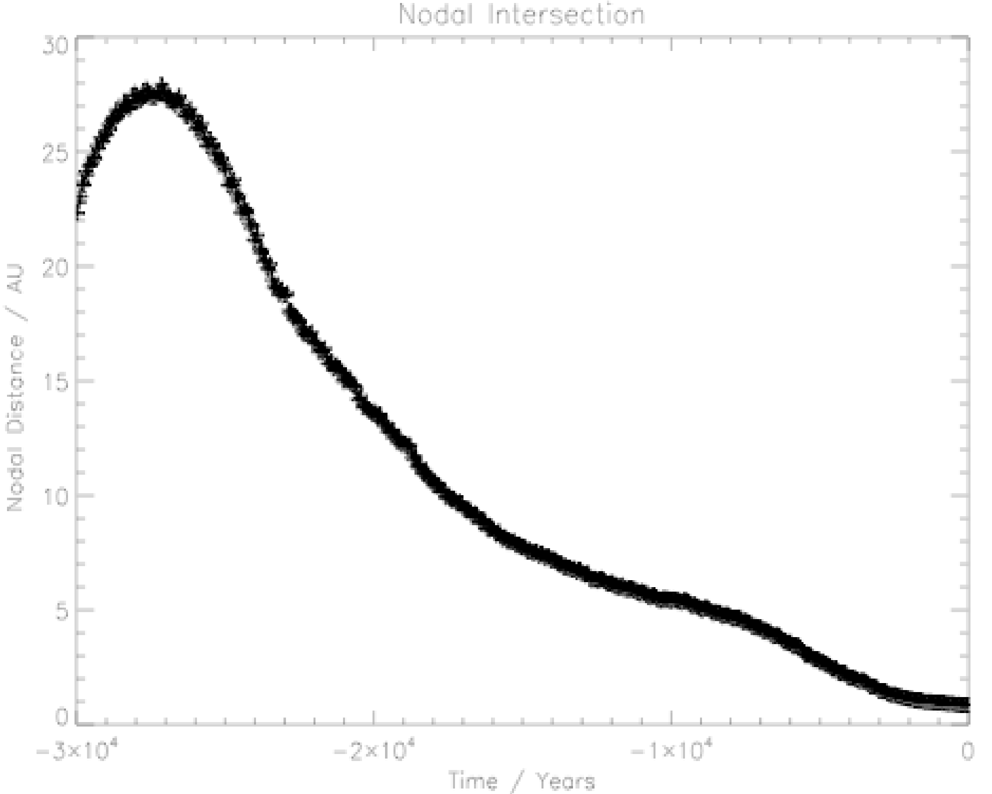


* The heliocentric distances for ascending and descending nodes were analysed.

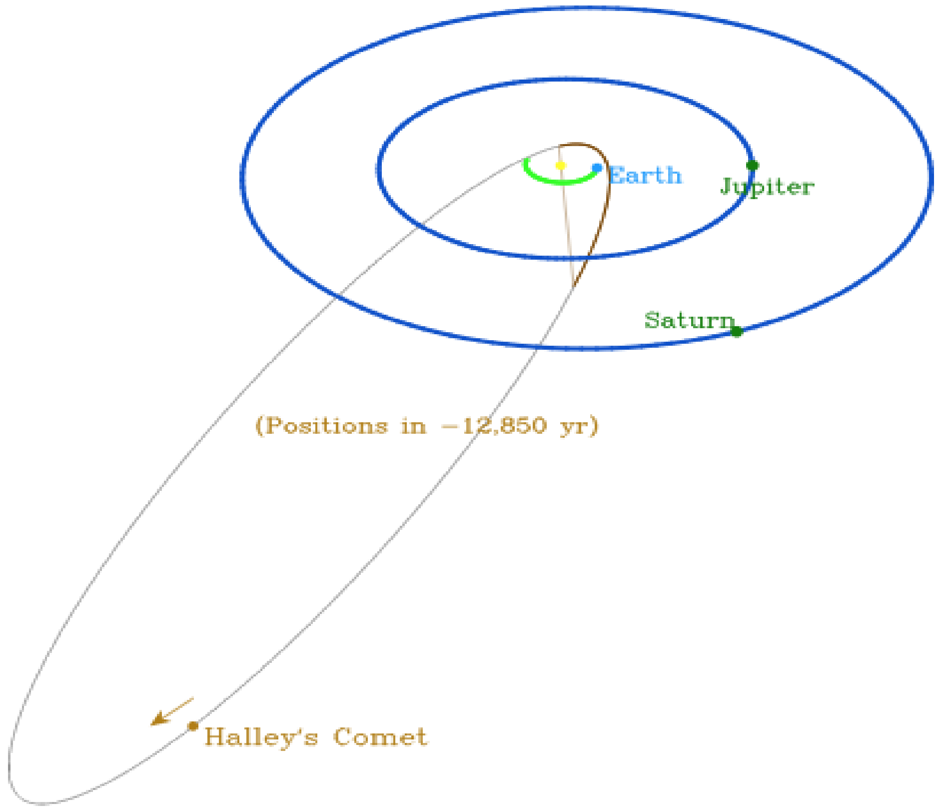
* It shows that there are possibilities for close encounters with Jupiter around this -12,000 time frame.

* Hence we assume that most of the particles would have got strong perturbations from Jupiter which suddenly changed its orbital parameters.

* Drastic variation in semi-major axis near -12,000. Orbits before this time cannot be very reliable for ejection models.

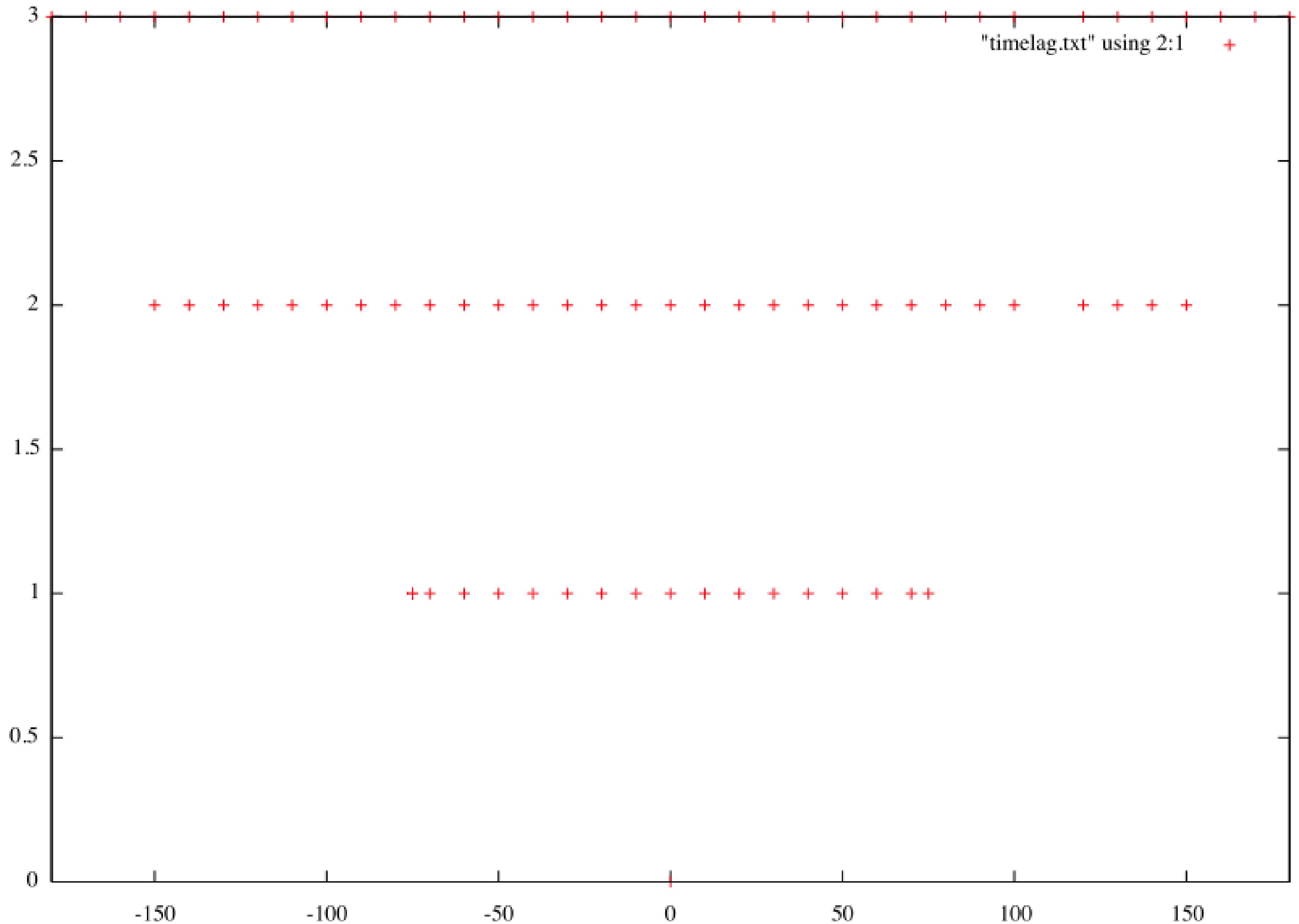


Orbit of Comet Halley in -12,850



2.2. Mean Anomaly Distribution

No. of Revolutions Vs Mean Anomaly (Degrees)



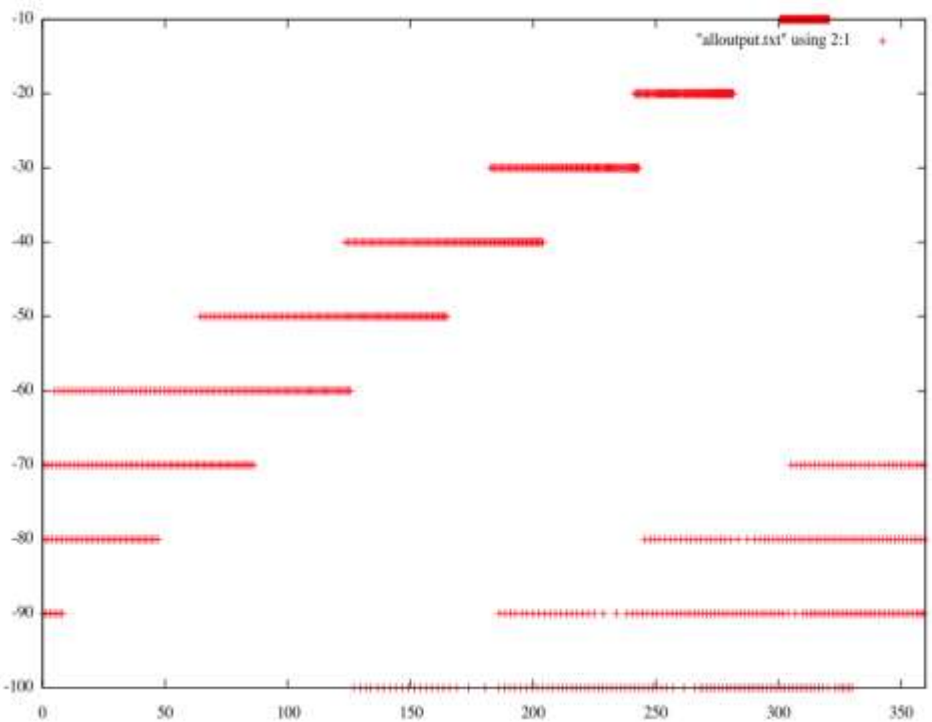
-31.6 yr | -15.8 yr | 0 yr | +15.8 yr | +31.6 yr

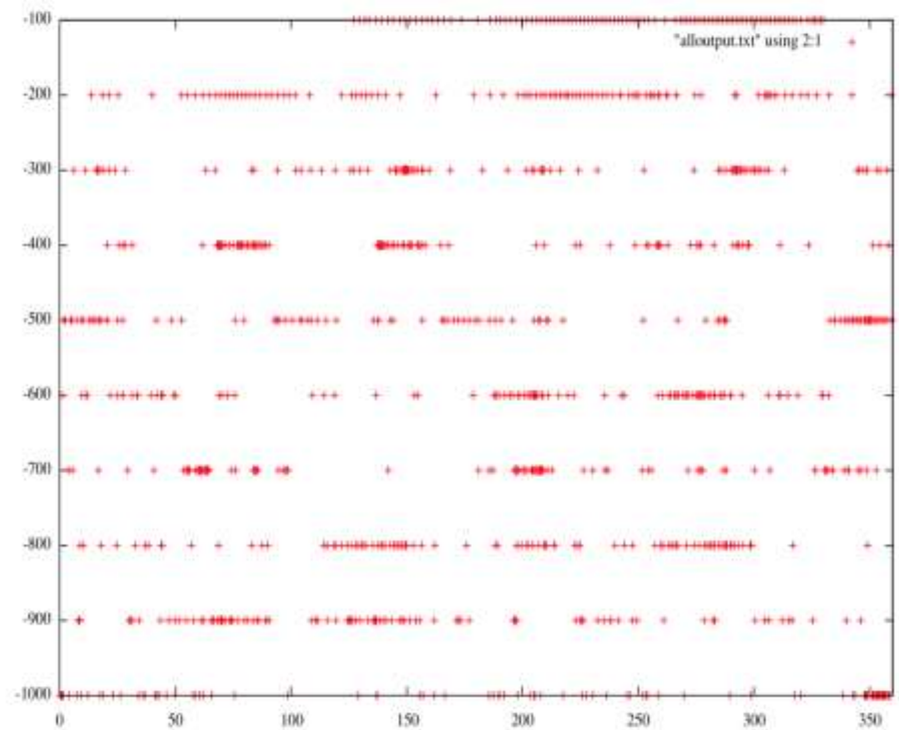
Ahead of Comet ← Position of Comet → Behind the Comet

* Mean anomaly distribution versus time for 100 test particles shows that particles spread along the entire orbit in due course of time

*The distribution is roughly uniform

Time (Years) Vs Mean Anomaly (Degrees from 0-360)





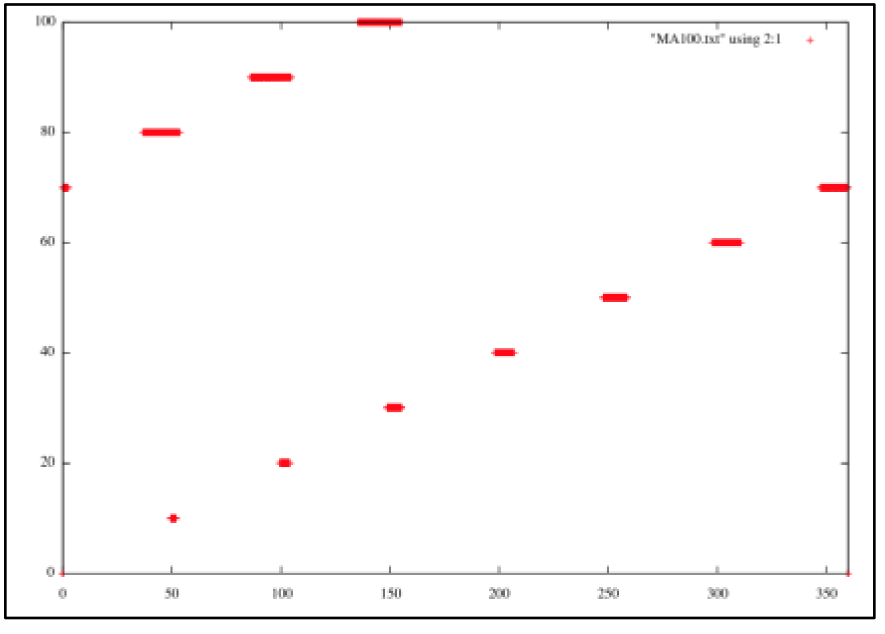
* Particles initially resonant behave differently

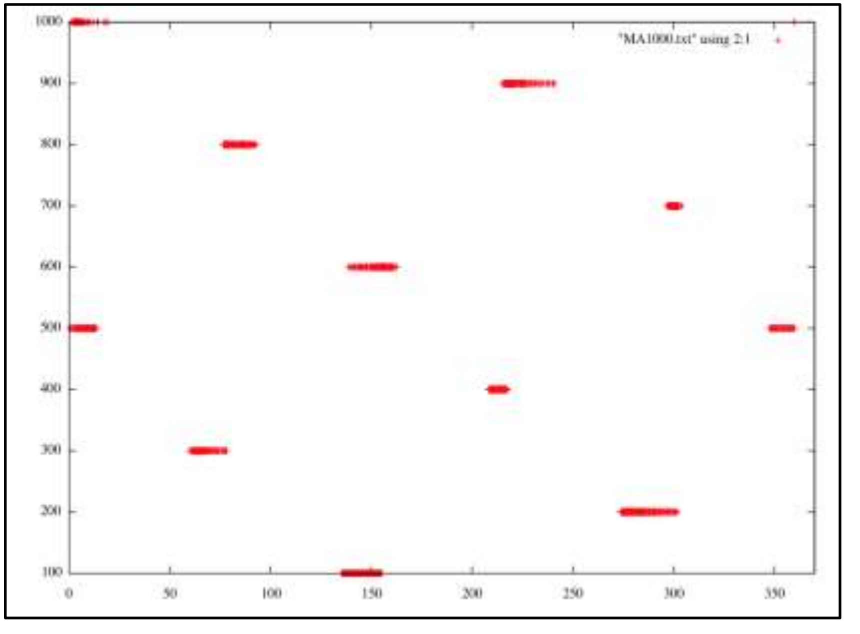
* They tend to stay together during its evolution because of periodic effects from Jupiter

*Such clustering of particles in space leads to meteor outbursts

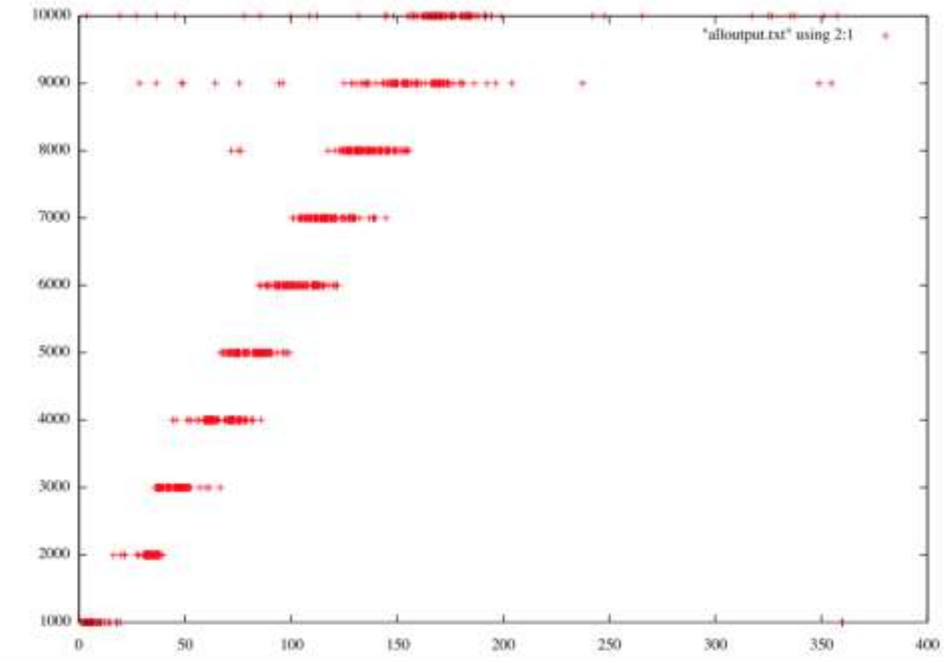
* Preliminary analysis shows about consecutive 5-6 years of enhanced Orionid activity

Time (Years) Vs Mean Anomaly (Degrees from 0-360)





Time (Years) Vs Mean Anomaly (Degrees from 0-360)



VALUABLE STATISTICS FROM IMO

Year	**ZHR** **IMO**	**IAU Telegram**
ORI 2010	40	40-50 predicted
ORI 2009	45	32 observed
ORI 2008	40	40 predicted
ORI 2007	70	65 +/- 3 observed
ORI 2006	>50	
ORI 1993		35 observed

ORI outbursts observed during 1933-1938, peaked in 1936 (Lovell 1954)

•Our calculations show that 1:6 resonance can occur if semi-major axis of the comet lies between 16.6 AU to 17.8 AU

•Hence it is possible that Halley's comet itself was resonant in ancient times.

•An ejection model incorporating this idea can populate a lot of resonant meteoroids in 3D space & track them forward in time

•Quantifying various contributions from other resonances with Jupiter like 2:13, 1:7 etc is another interesting area

3. Final Goal

3.1. To try different ejection epochs and extend the present analysis of Halley stream to correlate with past observed events of meteor outbursts and predict such events in future

3.2. Develop a fundamental understanding of outgassing phenomenon and the dynamical evolution of such meteoroids over long periods of time by developing a 3D phase space ejection model.

ENOUGH TO KEEP US BUSY TILL 2061 (ON AN OPTIMISTIC NOTE!!)

THANK YOU


ASTRONOMERS AT WORK
Let's dispel some common beliefs.
I NEVER USE A TELESCOPE
I NEVER GO NEAR A TELESCOPE
I NEVER EVEN LOOK UP.
S. Harris