

Cascading fragmentation of comet 73P/Schwassmann- Wachmann 3

Abedin Abedin, Tanyu Bonev

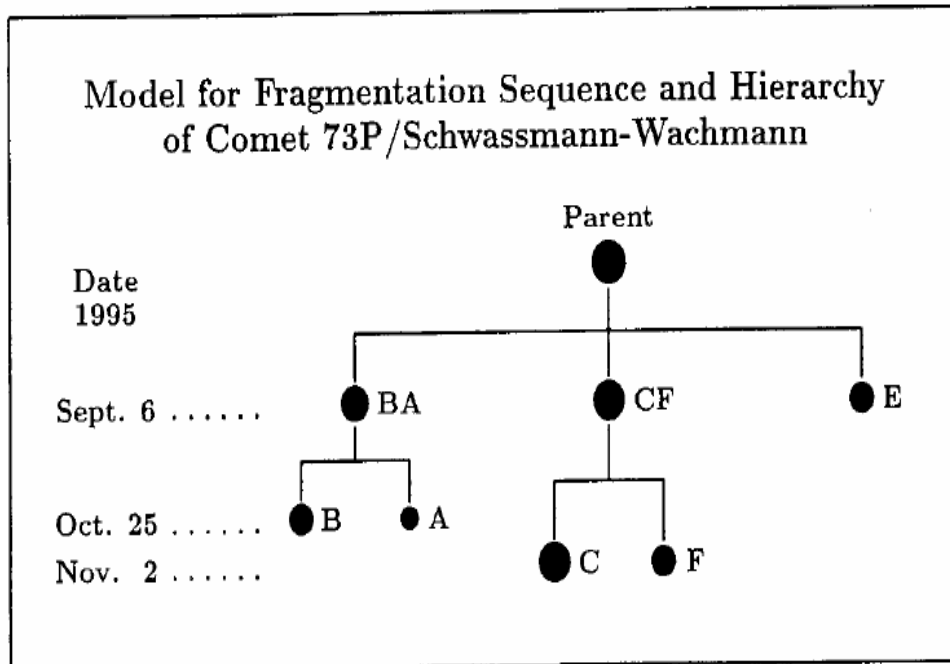
Institute of Astronomy,
Bulgarian Academy of Sciences,
Sofia, Bulgaria

Introduction

- **Discovery**
 - May 2nd, 1930; Arnold Schwassmann and Arno Arthur Wachmann, Hamburg observatory- Bergedorf
- **Orbit of comet 73P/Schwassmann-Wachmann 3**
 - Jupiter Family Comet
 - $P=5.4$ yrs, $q=0.94$ AU, (Sekanina 2005)
- **Fragmentation of the comet**
 - 1995 outburst, five large fragments (Sekanina 2005)
 - 2006 outburst, over 70 fragments
- **Why do we study split comets?**
 - Structure and properties of the “fresh material”
 - Distribution of the ices within the cometary nucleus
 - Ejection of large number of small particles (meteor streams)
 - Dynamics of the fragments and smaller particles
 - Investigation of the most primitive material in the Solar system

Fragmentation sequence and hierarchy of comet 73P/Schwassmann-Wachmann 3

Sekanina, 2005



Aim of this work:

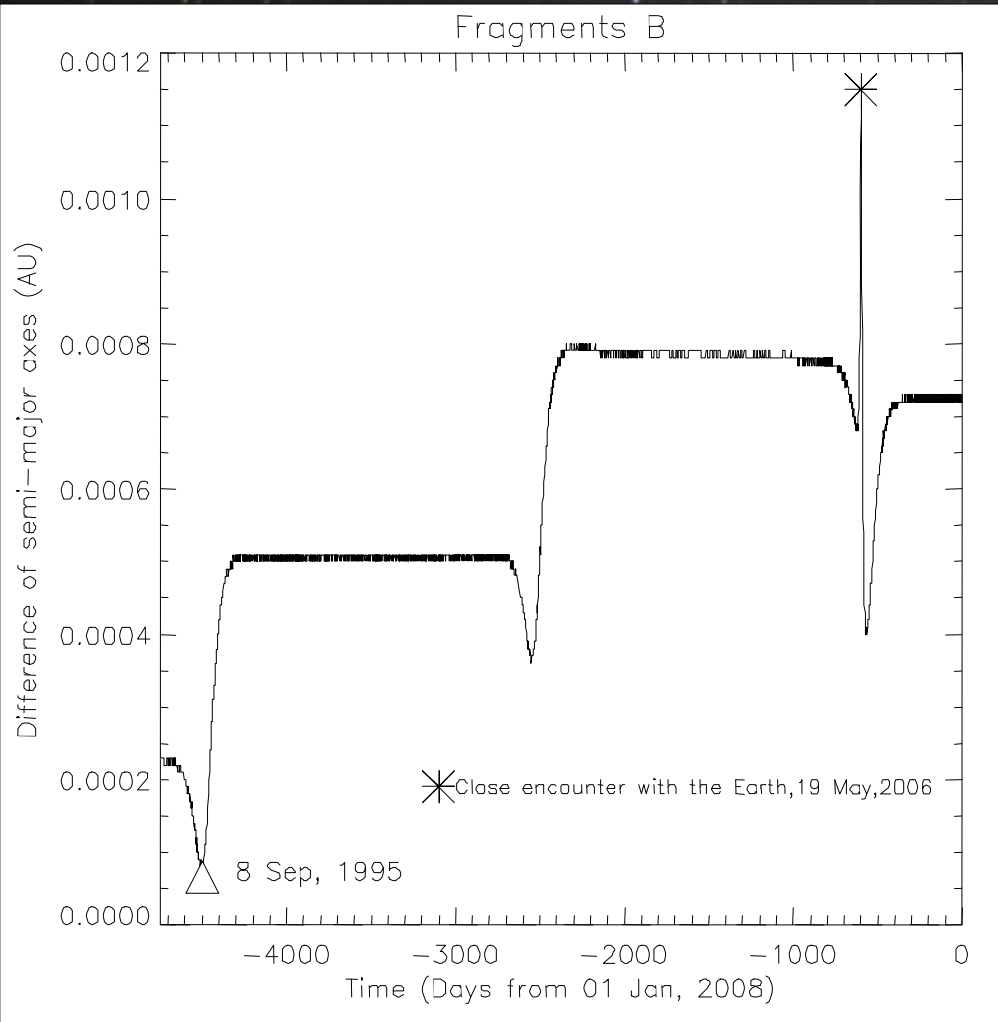
Derivation of the fragmentation sequence and hierarchy of the comet 73P/ S-W 3

Expansion of Sekanina's work and comparison of our model to his.

The Model

- Fragments B,C,E,G,H,J,K,L,M,N,P,Q and R
- Numerical backward integration
 - Orbital elements from JPL Horizon database:
<http://ssd.jpl.nasa.gov/sbdb.cgi>
 - Mercury6 package (Chambers,1999) – A Hybrid Symplectic integrator
 - RADAU 15 method (Everhart,1985)
 - All the planets from Mercury through Neptune with the largest asteroids: Ceres, Vesta, and Pallas (as perturbing bodies).
 - Considered non-gravitational parameters A1,A2 – due to the outgassing of the nuclei.
 - Time interval: From 1st Jan. 1995 (the year containing the initial outburst event) to 1st Jan. 2008 (well after the secondary outburst)
 - Step size: 1d
- Analysis of the results

Results

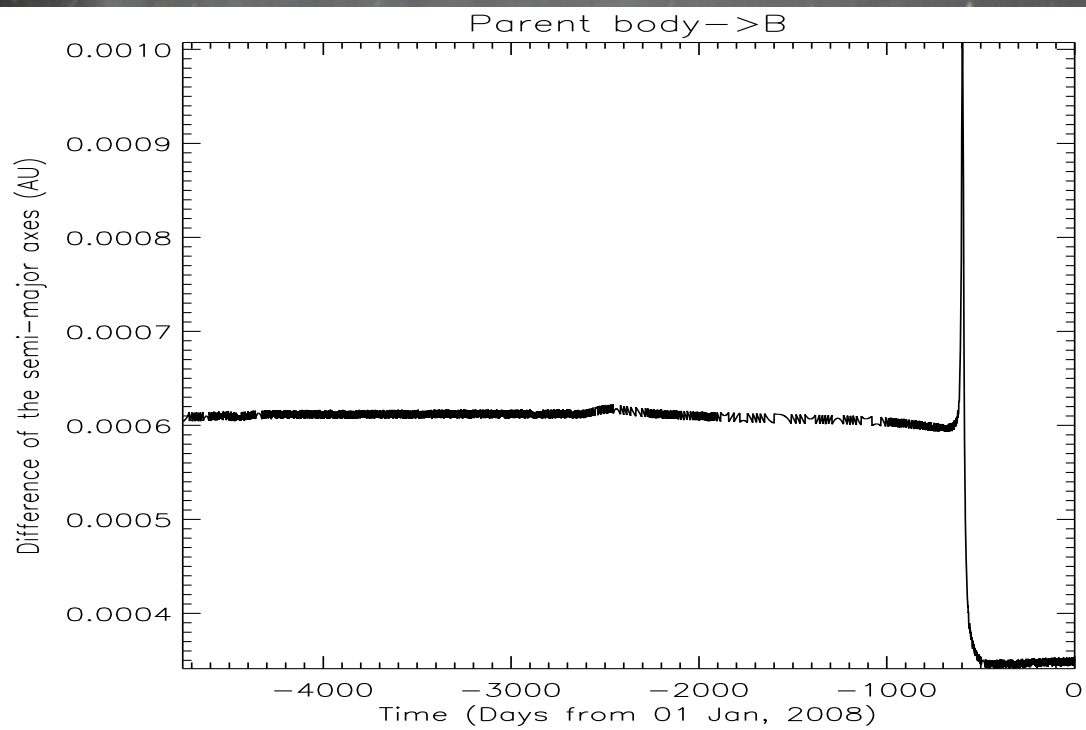
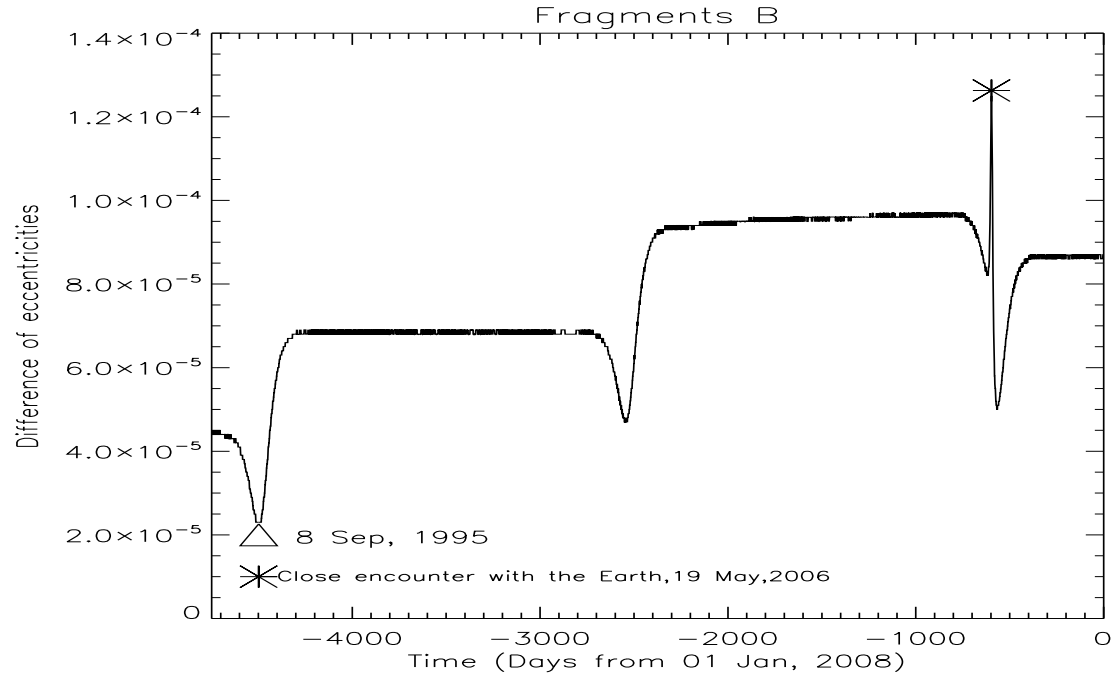


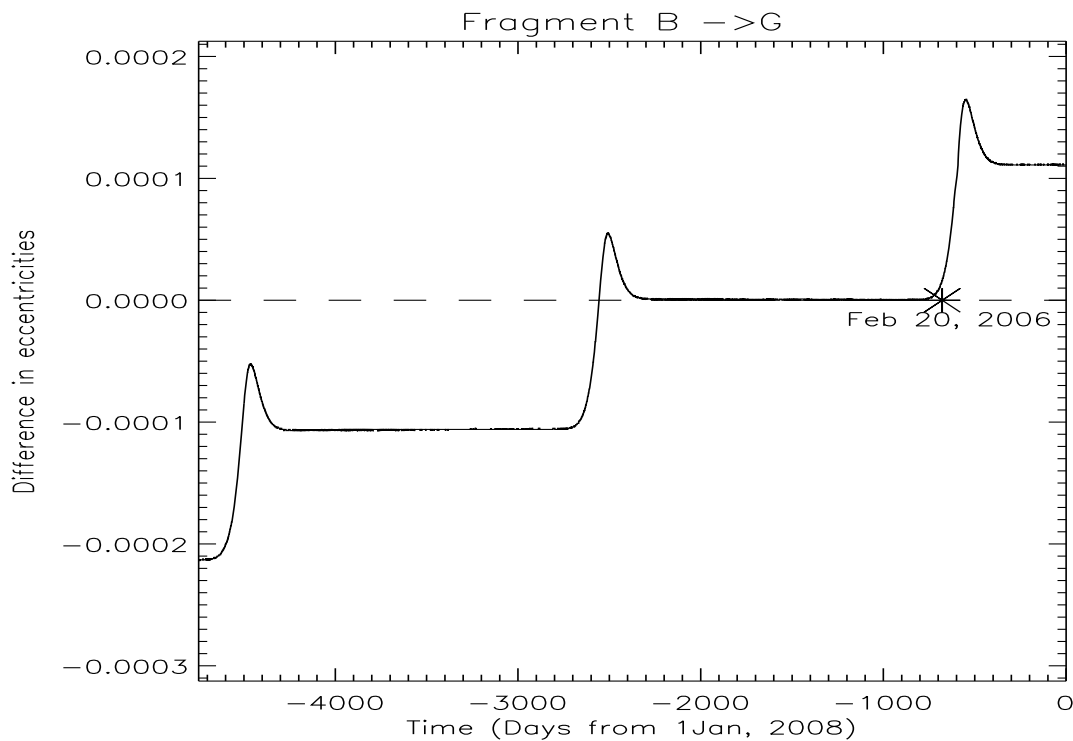
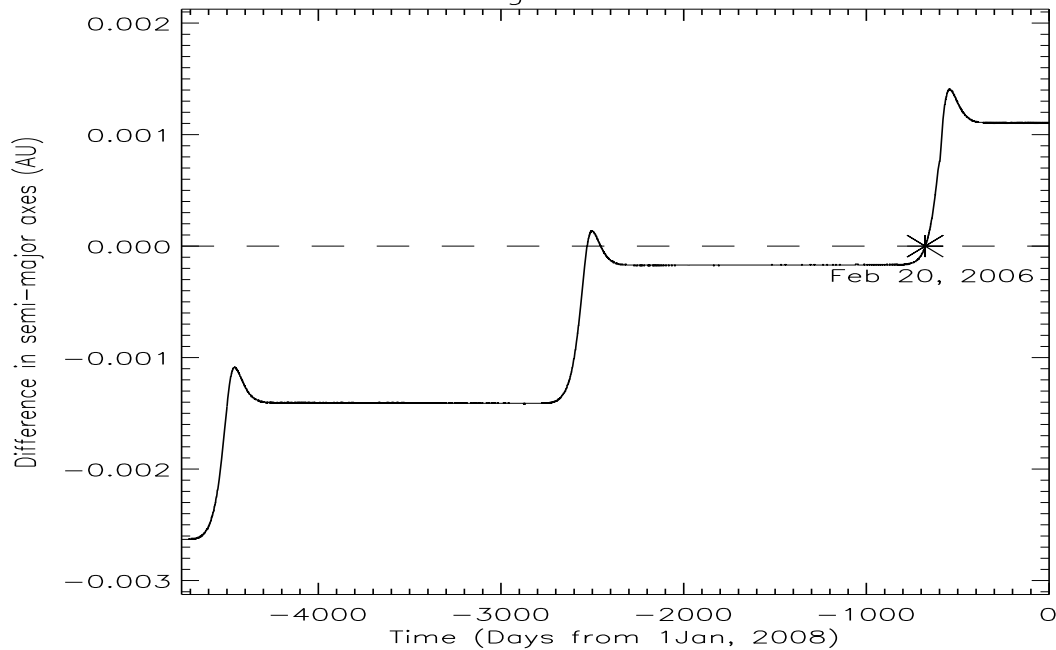
Results from numerical backward integration of the orbits of the primary nucleus and fragment B.

Fragmentation date: 8th Sep. 1995, +/- 2 days → (6th Sep. 1995, derived by Sekanina(2005)).

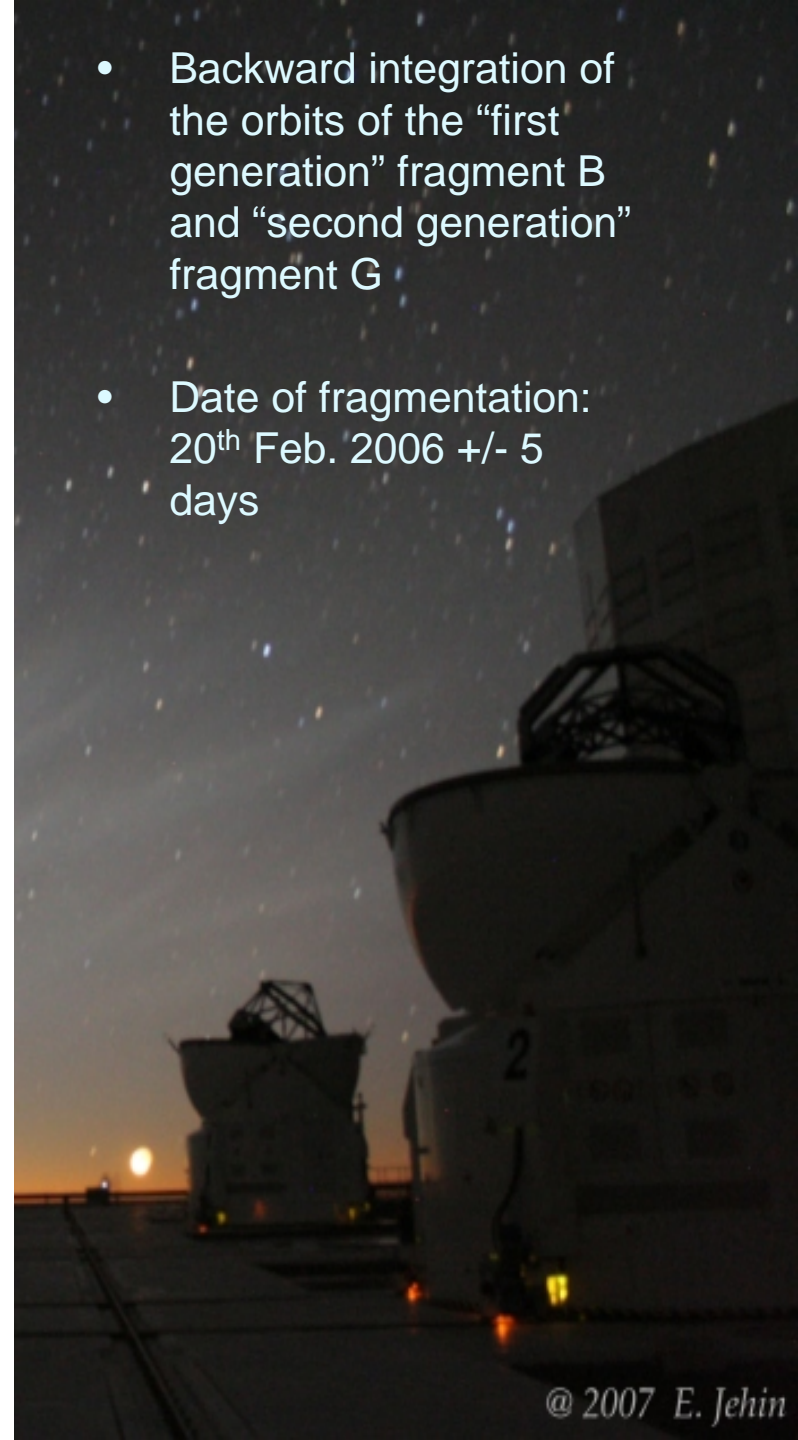
Close encounter with the Earth: 19th May, 2006, +/- 5 days

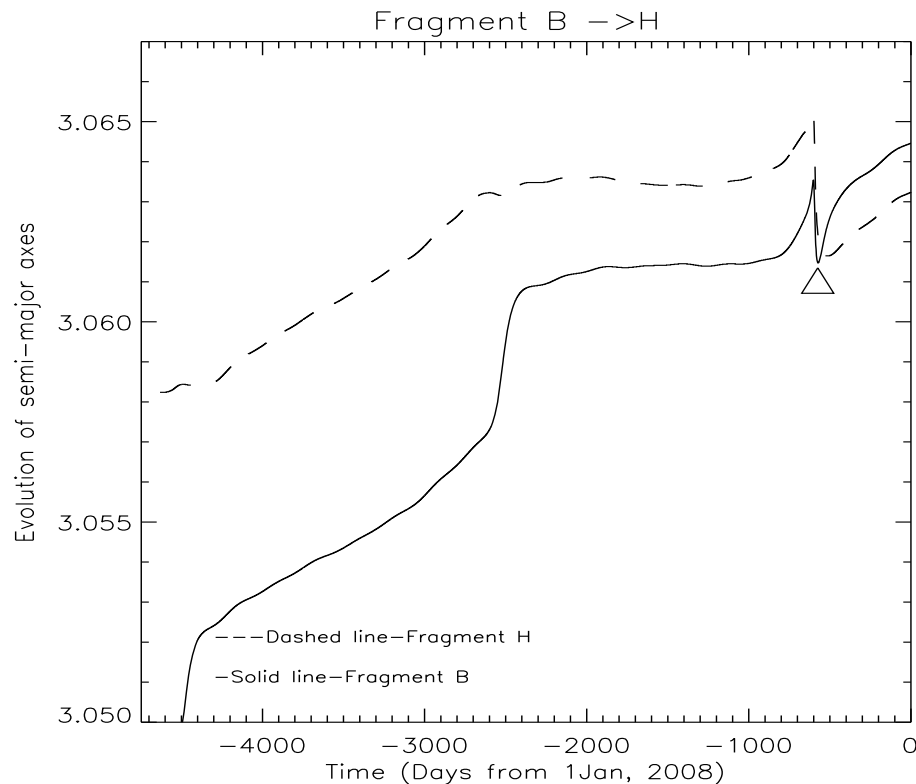
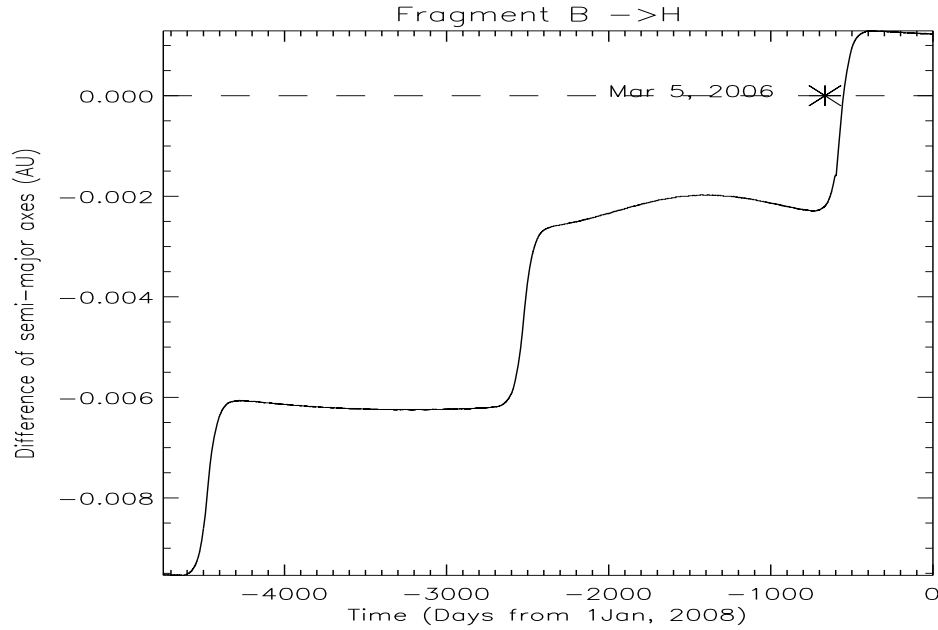
13th May, 2006, Reach et al(2009)



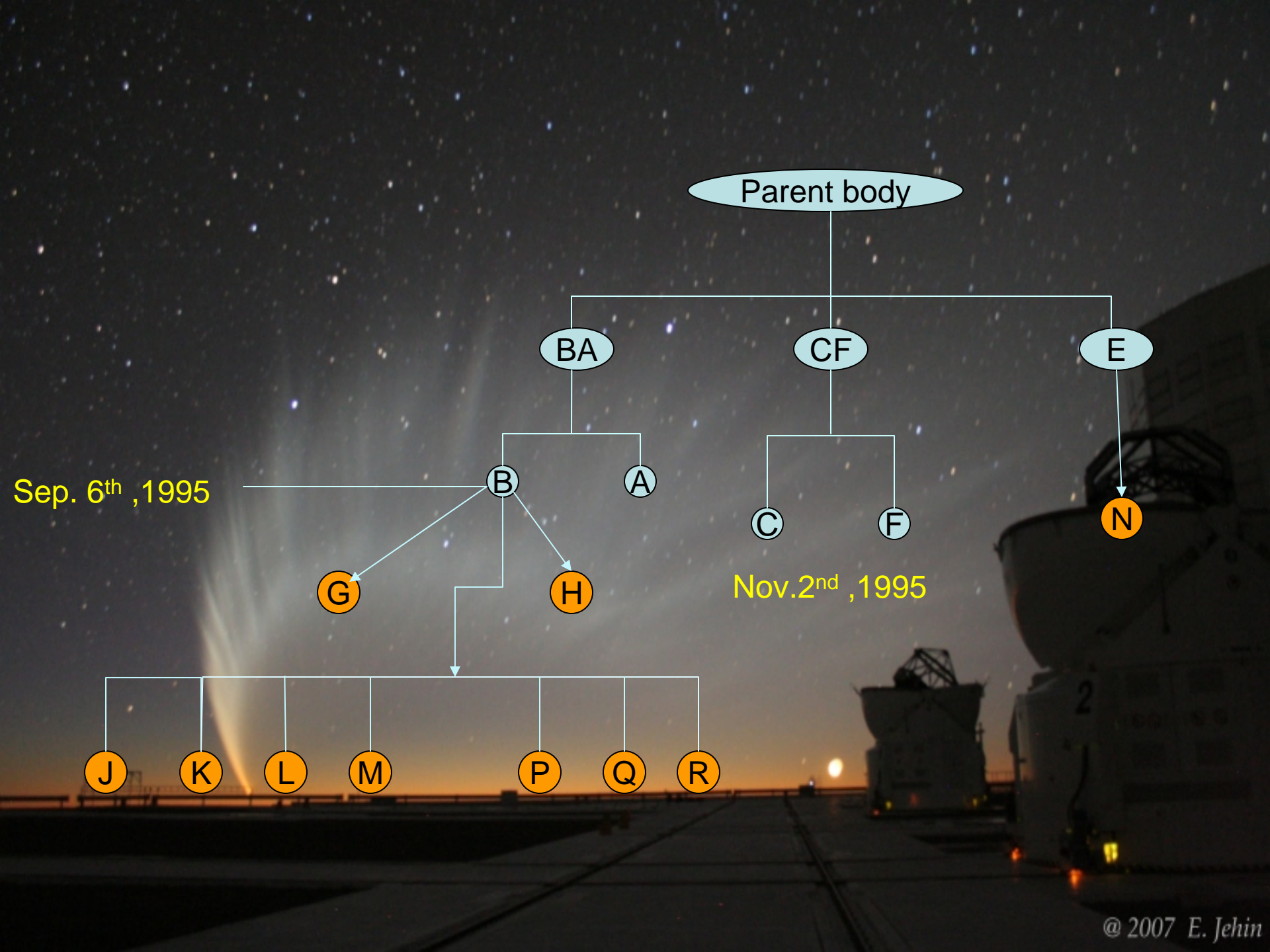


- Backward integration of the orbits of the “first generation” fragment B and “second generation” fragment G
- Date of fragmentation: 20th Feb. 2006 +/- 5 days





- Backward integration of the orbits of “first” generation fragment B and “second” generation fragment H
- Date of first observation (discovery) – 5th Mar. 2006.
- Date of fragmentation (according to our model) – 24th Apr. 2006, +/- 4 days.



Parent body

BA

CF

E

Sep. 6th, 1995

B

A

C

F

N

Nov. 2nd, 1995

G

H

J

K

L

M

P

Q

R

Conclusions and Future work

- Conclusions
 - Results for the “first” generation fragments agree well with Sekanina’s multi-parameter model.
 - Discrepancies in our model as compared to Sekanina’s for the “second” generation fragments, are probably due to the uncertainties in the orbital elements
- Future work
 - Improvement of the accuracy of the model by including the non-gravitational parameters for “second” generation fragments and more accurately determined orbital elements
 - Applying similar method for linking meteor showers to its parent comet (different non-gravitational forces)

A night sky filled with stars, with a large satellite dish antenna in the foreground on the right. The dish is illuminated from below, and a bright light source is visible on the horizon. The text is overlaid on the left side of the image.

• Acknowledgements

- Dr. David Asher for advices and discussions
- John Chambers for providing the “Mercury6” package to the publicity
- Dr. Galin Borisov (IA at BAS, Sofia) for useful ideas on how to implement the numerical integrations

References:

Everhart, E: 1985, *An efficient integrator that uses Gauss – Radau spacings*: *dcto.proc* ..185E

Sekanina, Z: 2005, *Comet 73P/Schwassmann-Wachmann 3. Nucleus fragmentation, Its light-curve signature and close approach to Earth in 2006*. *2005 ICQ* ...27..225S

Reach et al.: 2009, *Distribution and properties of fragments and debris from the split comet 73P/Schwassmann-Wachmann 3 as revealed by Spitzer Space Telescope*: *2009Icar.*.. 203.. 271 R

THANK YOU FOR YOUR
ATTENTION