KYUSHU UNIVERSITY

Practical method to identify orbital anomaly as spacecraft breakup

UETSUHARA Masahiko, NAKANIWA Yoshitaka, HANADA Toshiya

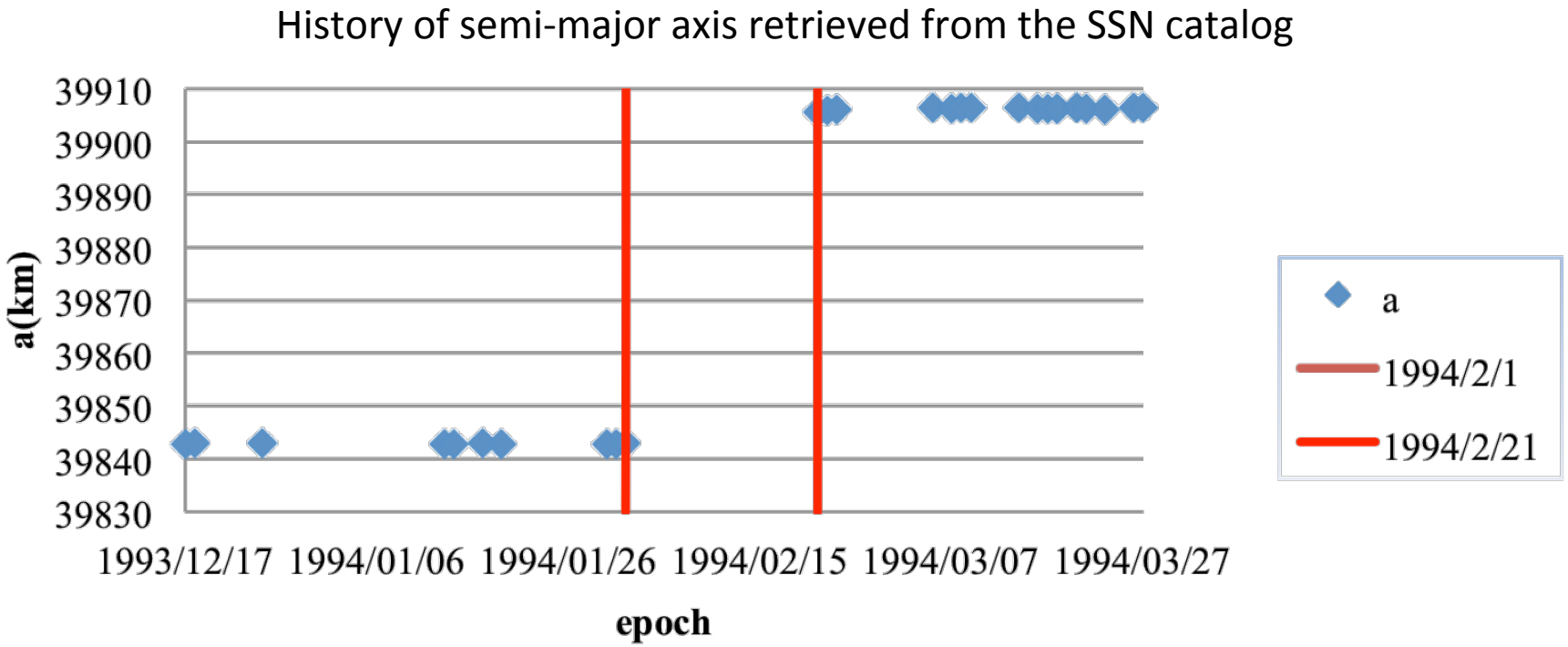
Kyushu University, Fukuoka, Japan

Motivations

- A lot of orbital anomalies have been found in the Earth orbits
- Some of them may be correlated with spacecraft breakups
- This study introduces a practical method to identify an orbital anomaly with a spacecraft breakup in the geostationary region

Test case

- The orbital anomaly of 1967-066G (Titan IIIC Transtage) found in February 1994

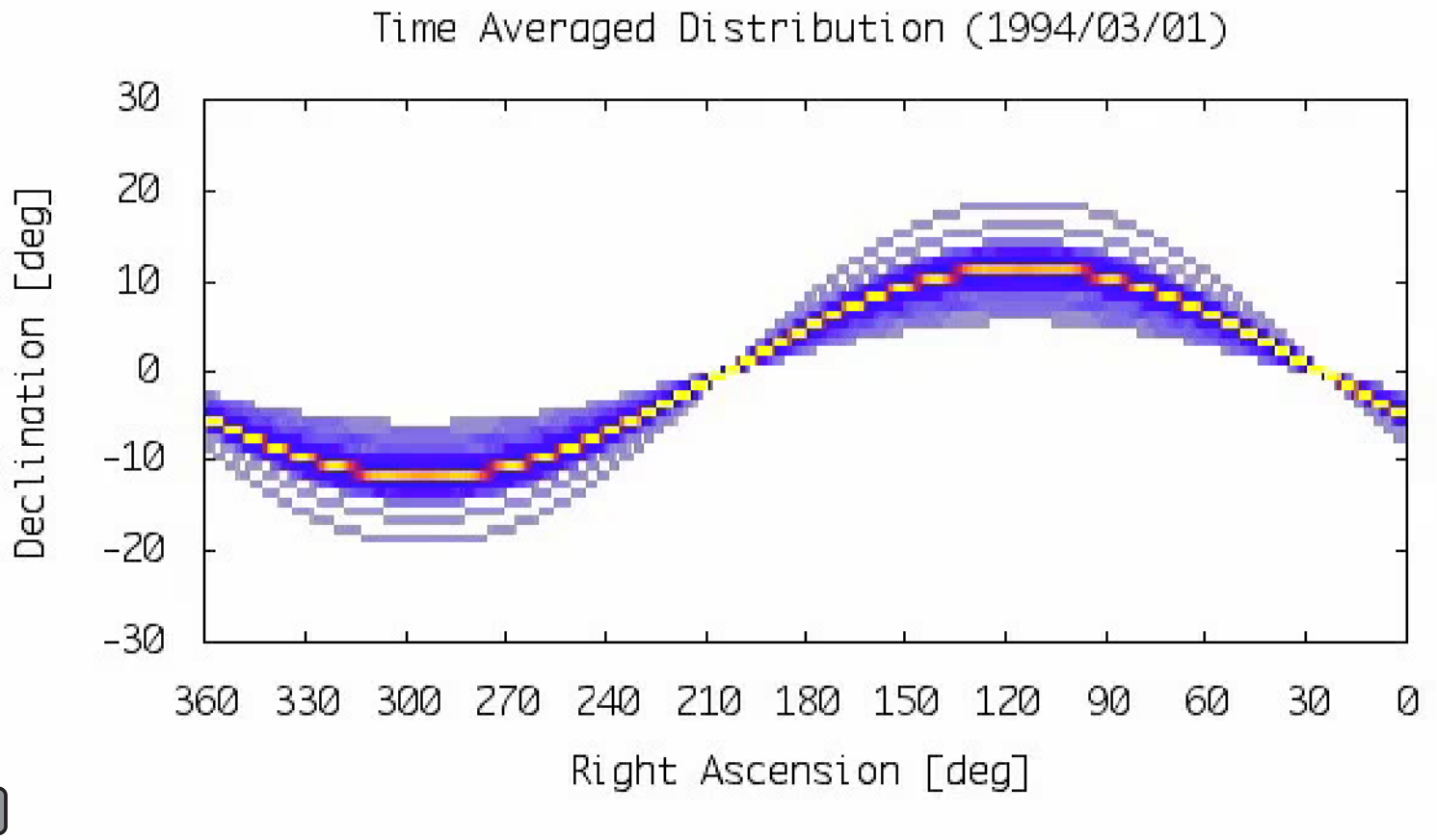


Simulations of fragments evolution

- Evolutions of the 1967-066G fragments are simulated

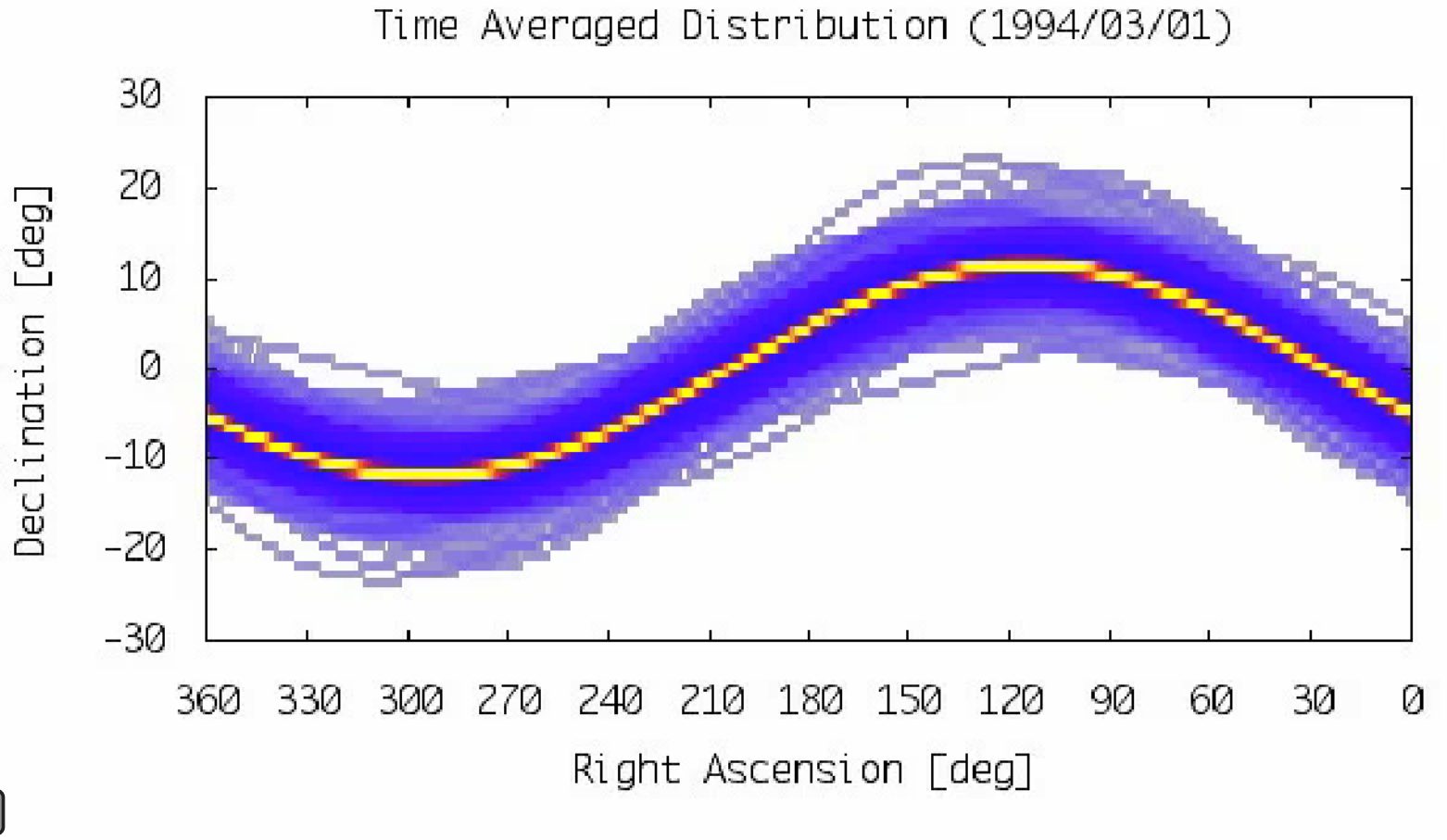
- Fragments generation
  - NASA standard breakup model (revision 2001)
    - Fatal explosion (scale factor = 1), Size > 0.1 m
  - 60 breakup epochs are randomly selected from 12:00UT 1 Feb. 1994 to 12:00UT 21 Feb. 1994
- Fragments propagation
  - Analytical solutions (J2, third-body (Sun & Moon))
  - 54 years propagation period (1994 - 2048)

Population evolution (Deterministic breakup epoch)



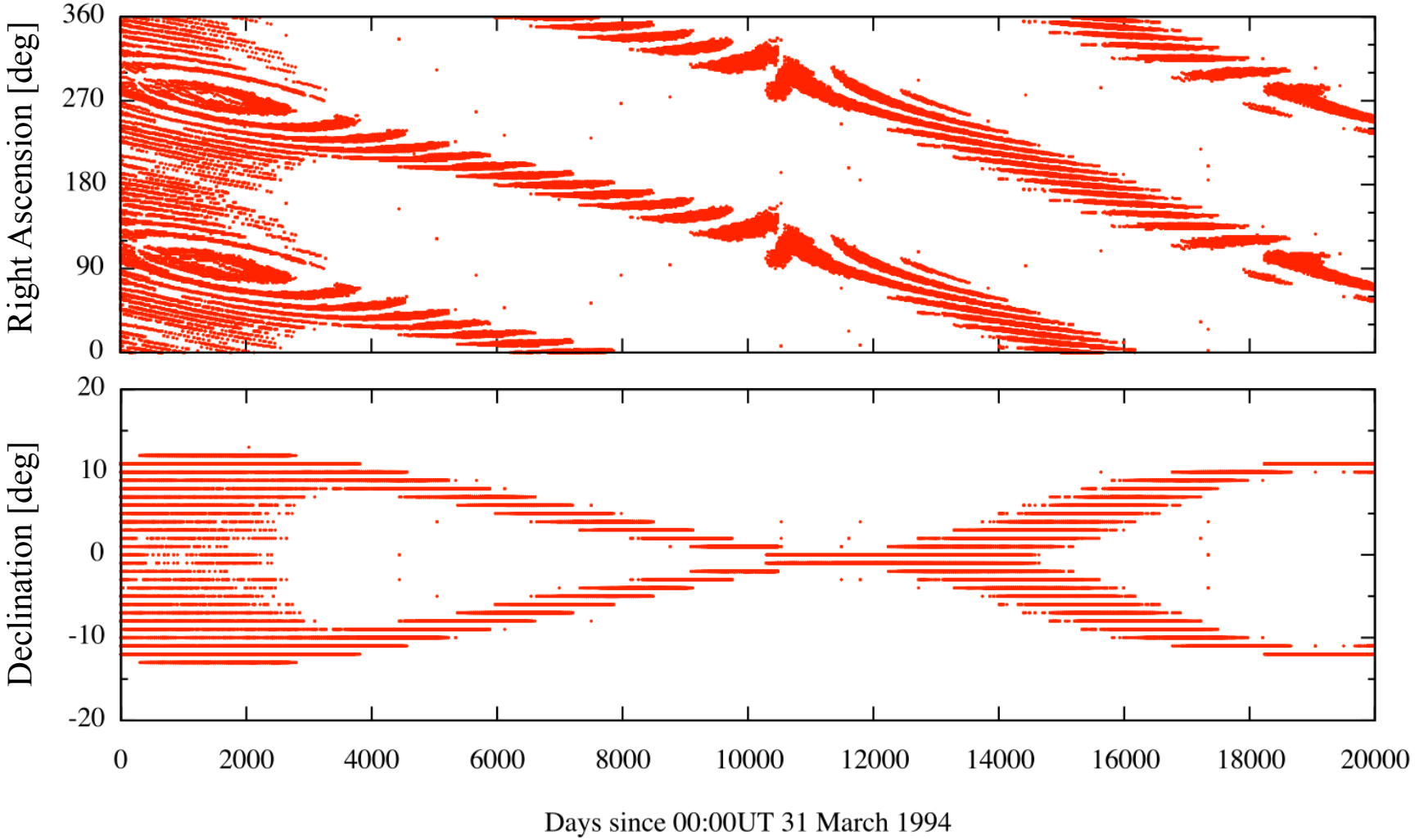
Two peak regions show periodic motions

Population evolution (60 breakup epochs)



Yellow regions indicate where we have to conduct survey observations

Traces of peak points



Proposal of the Practical Method

Assumptions applied to breakup fragments

- Temporal positions are unknown (= not predictable)
- Orbital paths are known (= predictable)

Practical method to identify orbital anomaly as spacecraft breakup

1. Assuming an orbital anomaly as a breakup to conduct predictive analyses
2. **Parking surveys of peak regions found in a population snapshot**
3. Follow-up observations for orbit determinations
4. Back-ward propagations for origin identification, event identification, and breakup epoch estimation

Conclusions

- Long-term orbital evolutions of breakup fragments conclude that their orbital planes will converge into several peak regions in inertial space even if the breakup epoch has 20 days uncertainty

- We can identify an orbital anomaly as a breakup event by searching for breakup fragments in the peak regions