INFLUENCE OF INITIAL CONDITIONS ON THE REACCUMULATION OF FRAGMENTED ASTEROIDS

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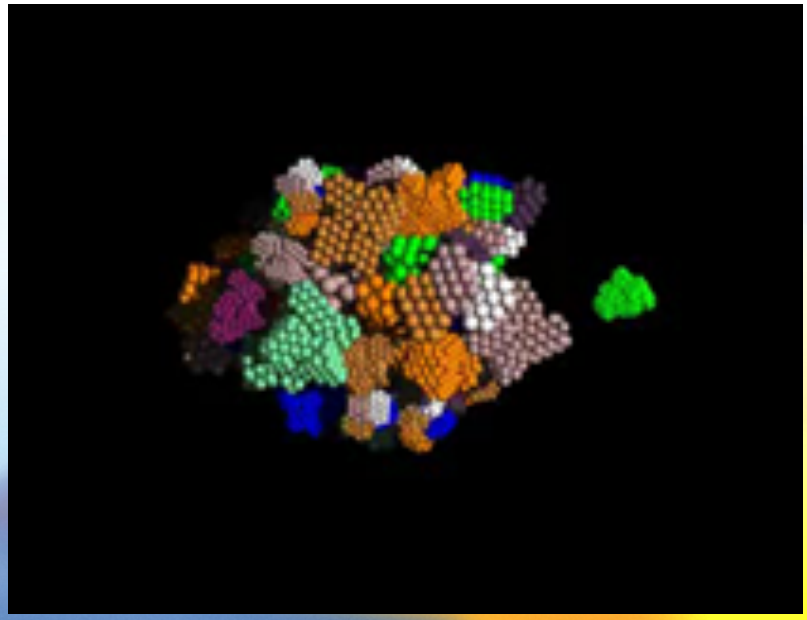


Why do we want to know about the internal structures of small bodies?

Scientific reasons:

- ***Internal structures are related to collisional history***
- ***Clues about the formation mechanisms of planetesimals.***
- ***Applications to space missions: AIDA***

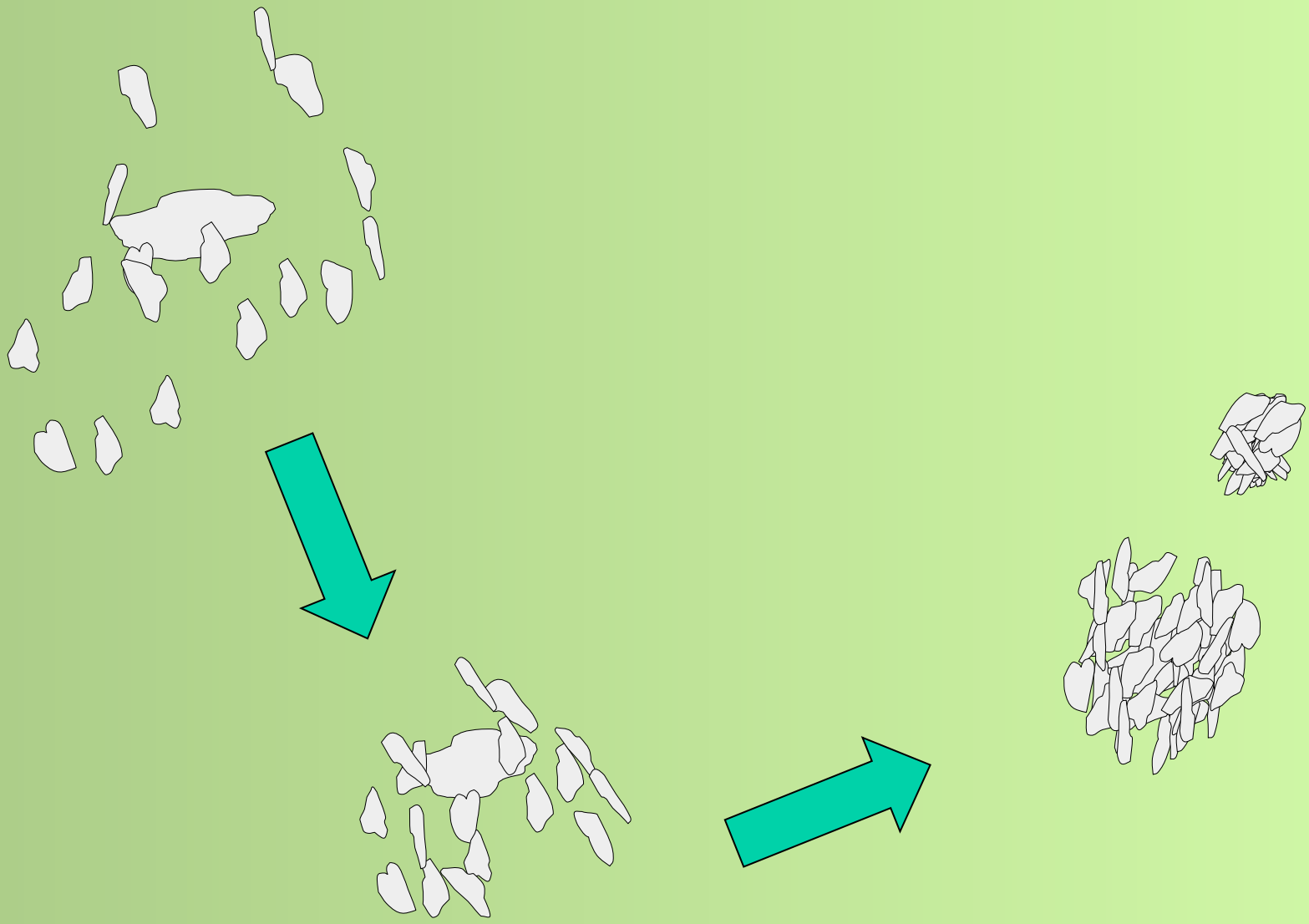
and a "social-scientific" reason:

- ***Strategies of mitigation of the risk of impacts on Earth.***

- ***Rubble-piles should be common (40-100%) among asteroids in the 100s m -100 km range (Campo B., Petit and Farinella, 2001)***

What are the main evidences for gravitational aggregates (rubble-piles)?

- *Low bulk densities (asteroids and comets?)*
- *Limit on rotational periods of asteroids*
- *Asteroid Itokawa*



How do we study that?

Our goal: try and reproduce observed features of gravitational aggregates by means of

- ***non-spherical components with a suitable mass spectra***
- ***Different initial conditions for the system (volume; ang. mom.; m1/M…)***

Enquiring into internal structures

Different initial conditions

Numerical simulations

Checking the obtained values of porosity, period and m1/M

Seeking relationships among all this parameters

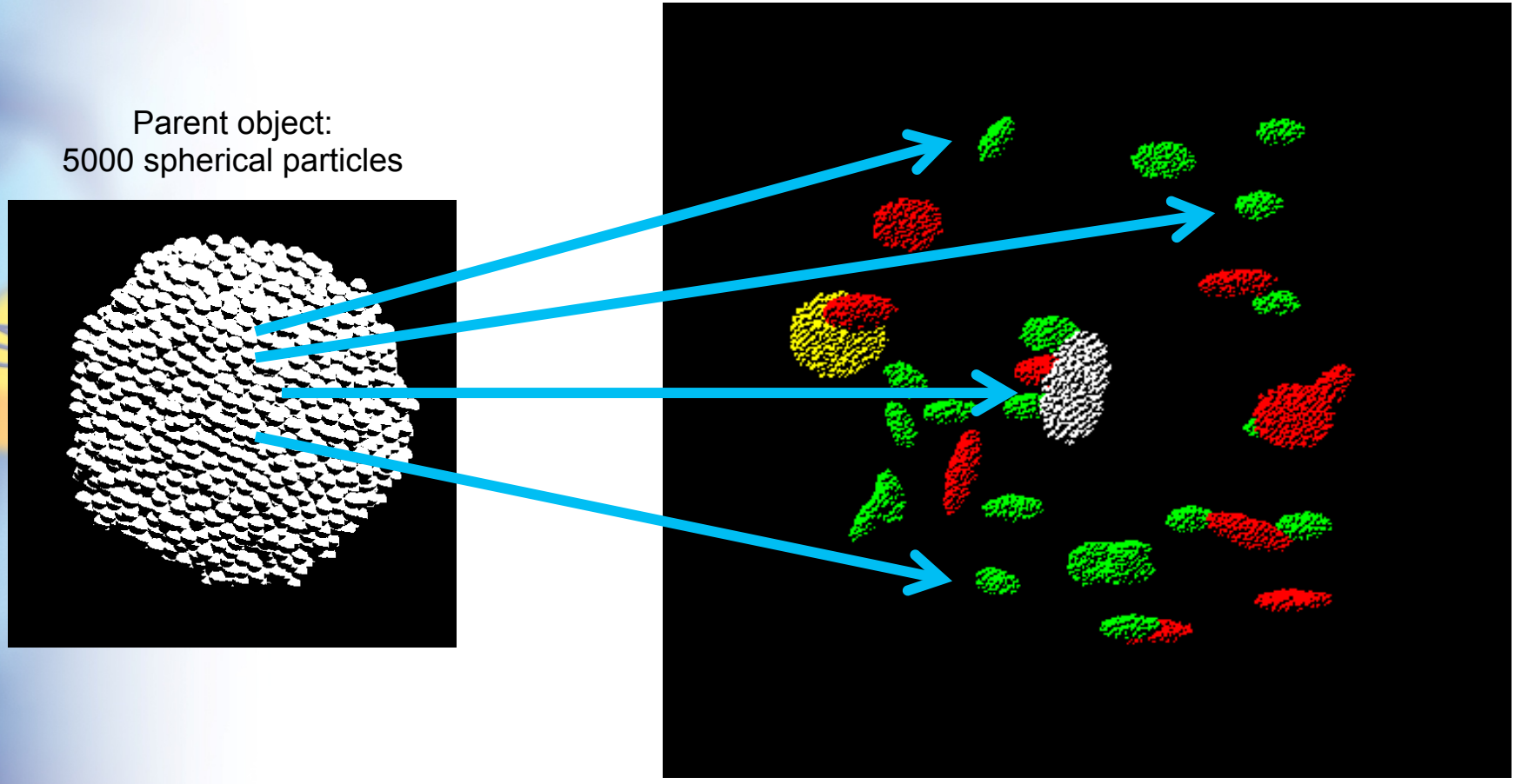
Mass and shape distributions of asteroid components unknown.

- Lab. experiments at NASA-Ames Vertical Gun Range (July 2013) with 6 shots on irregular shape (non-spherical) targets at V~4-5 km/s.
- Synthetic mass and shape distributions drawn at random from experimental ones (This presentation is mainly on S-type density).

Exploring internal structure

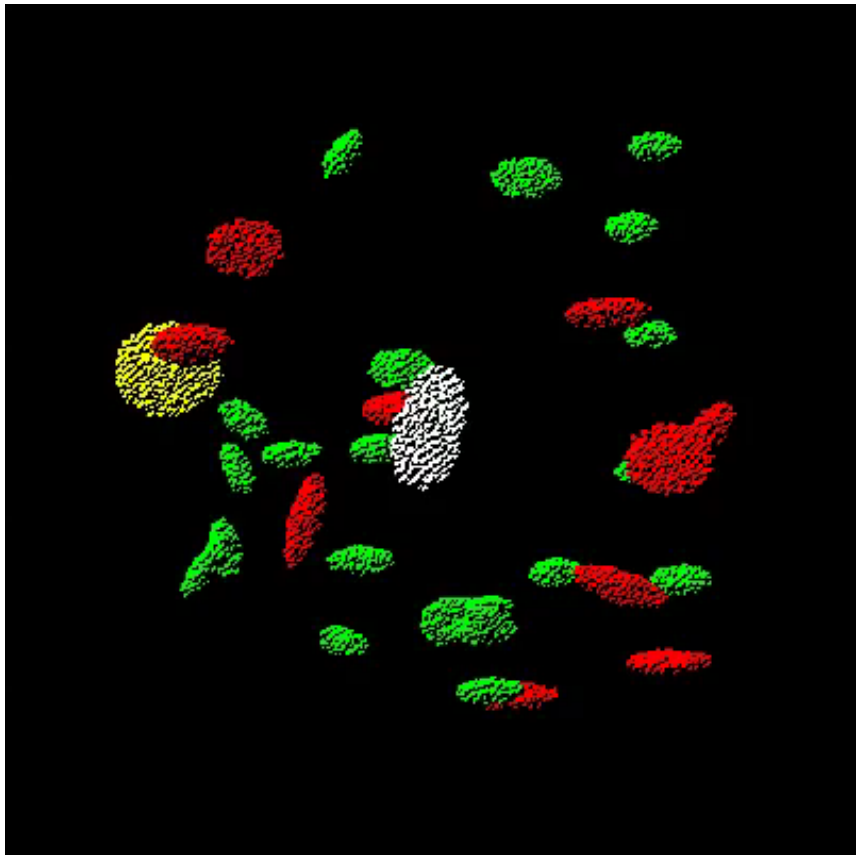
- PKDGRAV DEM (Schwartz et al., 2012)
  - Make rigid aggregates with any shape (unbreakable)
  - Position aggregates in space with random rotation and ***V*** | E<0
  - Allow for dynamical and collisional evolution

Parent object:
5000 spherical particles



Little surprise…

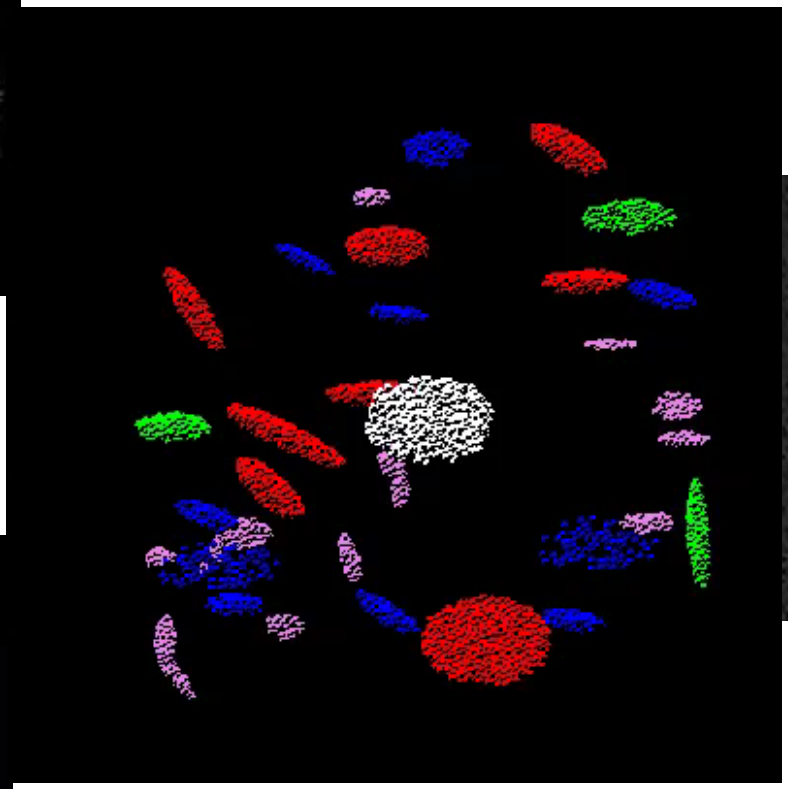
Parent body “core” end position is NOT necessarily in the core of reaccumulated asteroid structure…

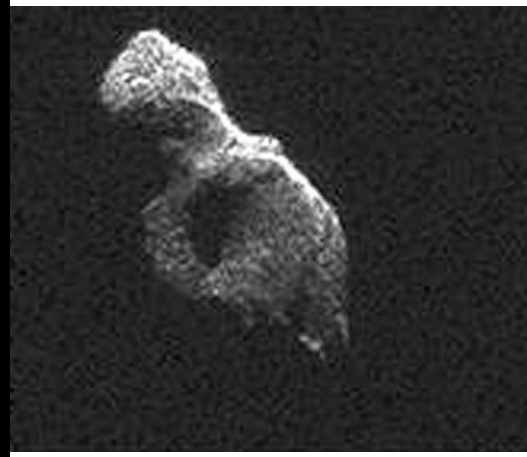


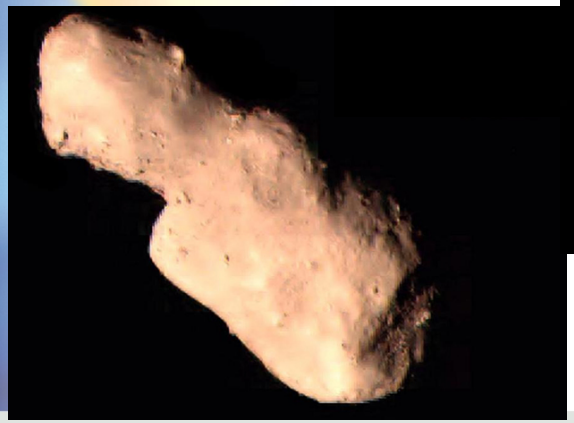
- “Core” (LF) is displaced by first-comer fragments
- Most of reaccumulation does not occur “upon” or “arund” LF.

…. Elongated bodies may form!!!

Itokawa - 2014HQ124 – Toutatis - Ida – *like* structures are simply likely outcomes of reaccumulation process?







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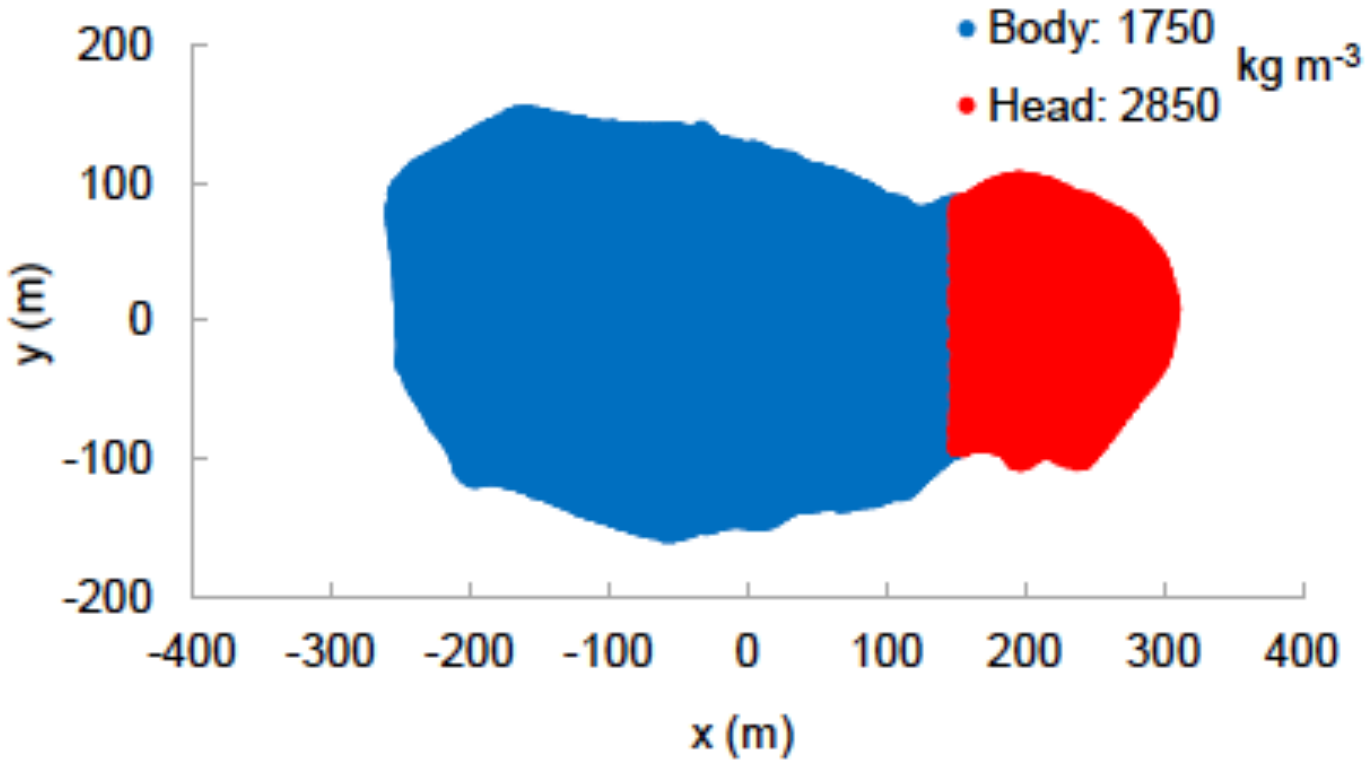
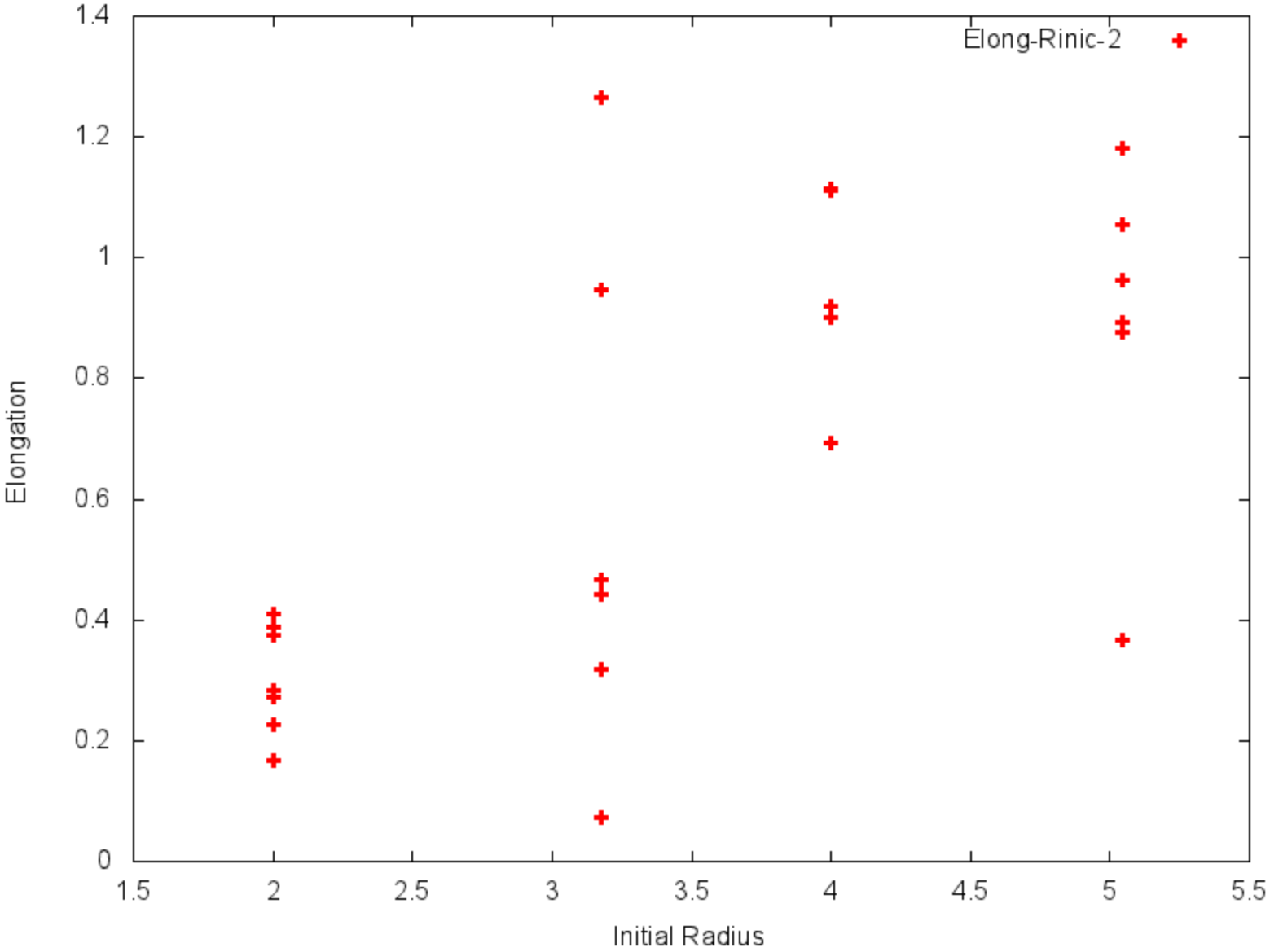
Astronomy & Astrophysics

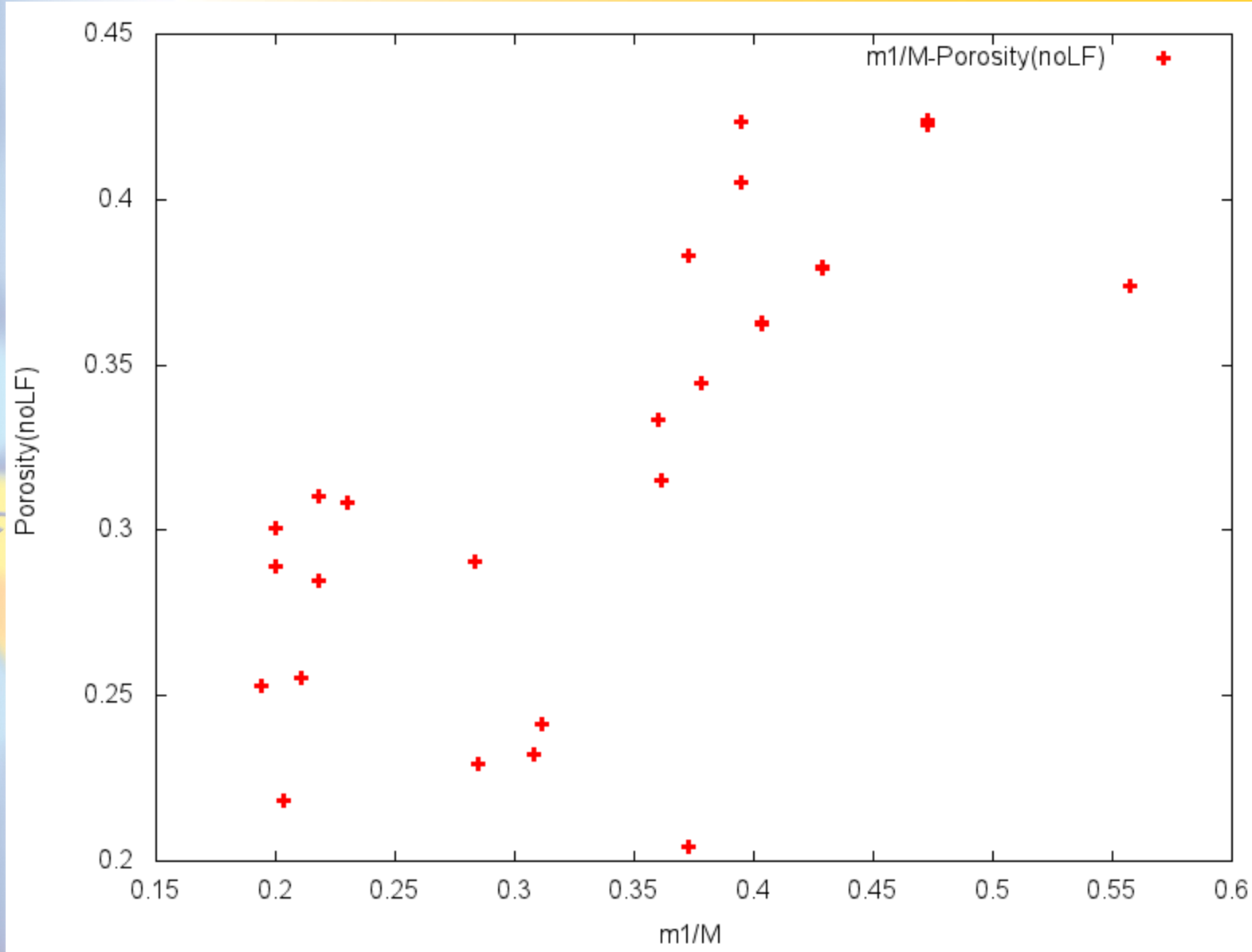
The internal structure of asteroid (25143) Itokawa as revealed by detection of YORP spin-up⋆,⋆⋆

S. C. Lowry[1], P. R. Weissman[2], S. R. Duddy[1], B. Rozitis[3], A. Fitzsimmons[4], S. F. Green[3], M. D. Hicks[2], C. Snodgrass[5], S. D. Wolters[3], S. R. Chesley[2], J. Pittichová[2], and P. van Oers[6]



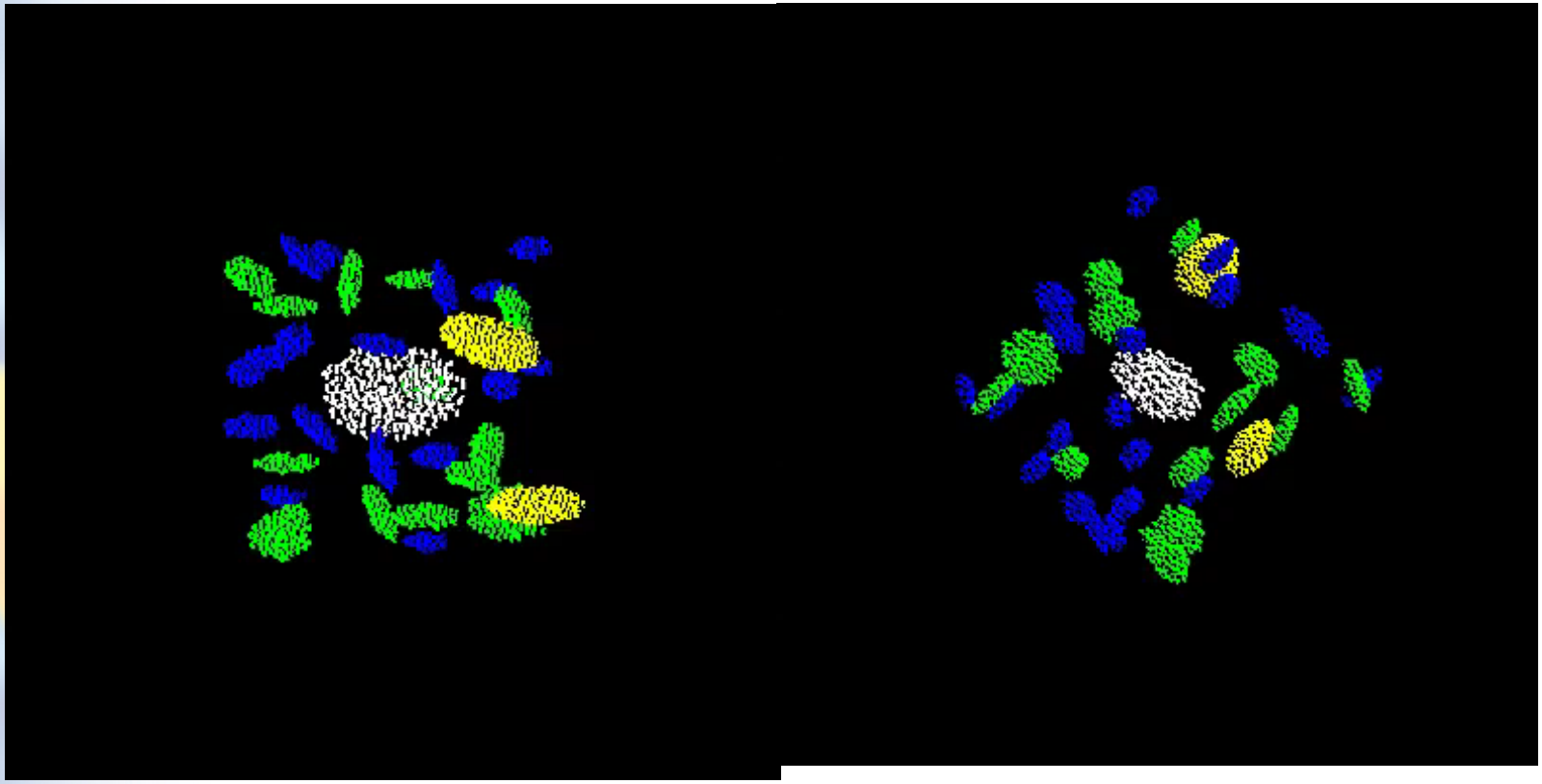
	Itokawa (Lowry et al, 2014)	Simulations (ρ_{comp} scaled)
ρ (kg/m^3) "head"	2850±500	2850±20
ρ (kg/m^3) "body"	1750±110	1910±30
m_{LF}/M	0.20	0.20-0.40


Elong-Rinic-2
Elongation
Initial Radius
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.5
2
2.5
3
3.5
4
4.5
5
5.5


m1/M-Porosity(noLF)
Porosity(noLF)
m1/M
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6

Possible natural way to get binaries

(NO YORP, NO fission, …: just gravitational reaccumulation with some initial angular momentum)



Conclusions

1. Largest fragments are not necessarily in the centre of grav. Aggregates

2. Elongated shapes may form as a natural reaccumulation process (no need of high spins/aborted binaries)

3. There seems to be some Porosity-Mass ratio and Elong.-Initial system size dependence,.

4. No Elong.-Period nor Elong.-Mass ratio dependence is found.

5. Intriguing possibility to form binary systems.

Current-future work

- Complete simulation sets for comets (67P)
- Compare to the few well determined asteroid densities
- Effects of collisions on pre-shattered asteroids
- Reproduce the binary system *Didymos* (AIDA mission target)