

Dust Particle Tracking at Comet 67P/Churyumov-Gerasimenko

General Idea & Current Approach

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General Idea

Background

Figure 1: 67P's active surface  landru79

General Idea

Background

Figure 2: Image sequence taken on Jan 6th, 2016 @ ~ 2 AU outbound

General Idea

Background

Figure 3: Modified image sequence

General Idea

Background

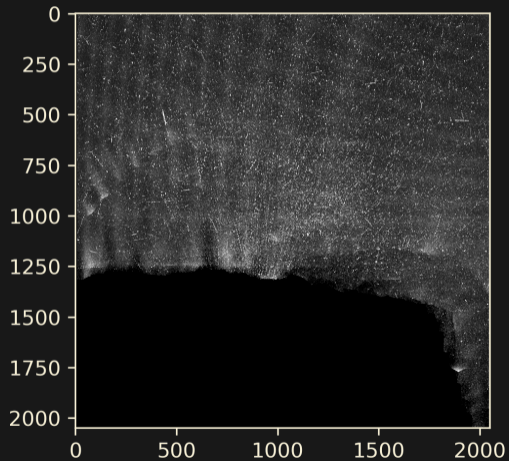


Figure 4: Stacked image sequence

General Idea

Background

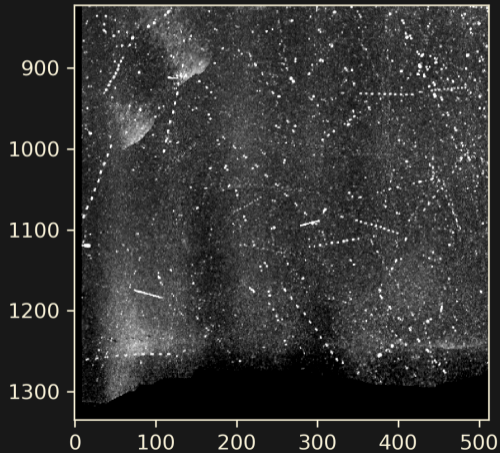


Figure 5: Zoomed-in area of stacked image sequence

General Idea

Previous work

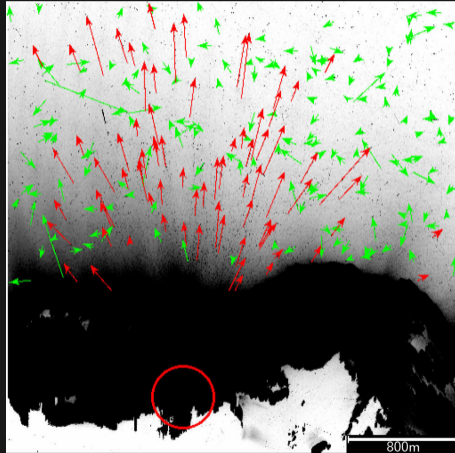


Figure 6: Manually tracked particles (Agarwal et al., 2016)

Step I: Particle Detection

Identifying point sources

Figure 7: Particle detection with SExtractor software

Step II: Particle Tracking

Utilizing different time intervals

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Step II: Particle Tracking

Preliminary results

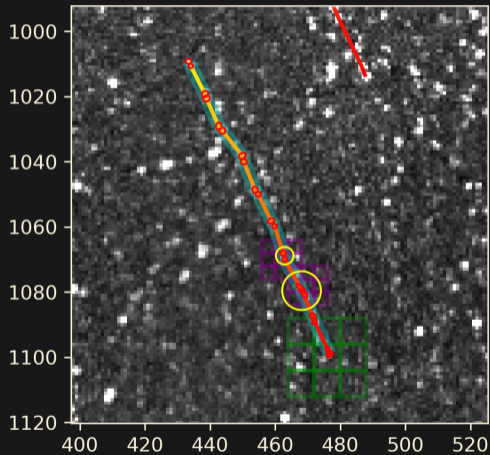


Figure 8: Single particle track

Step II: Particle Tracking

Preliminary results

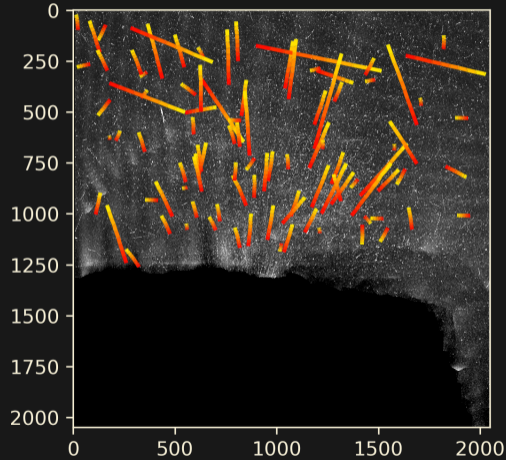


Figure 9: 'Good' particle tracks

Step II: Particle Tracking

Preliminary results

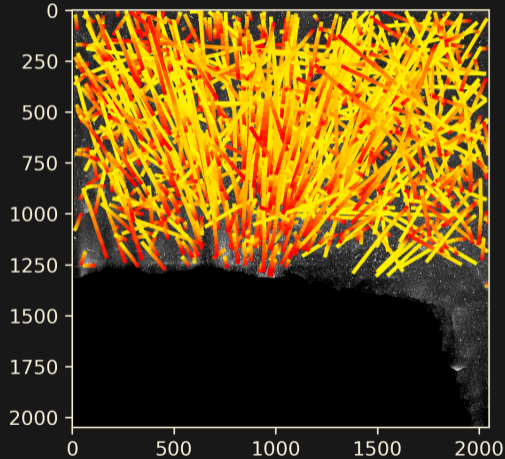


Figure 10: Particle tracks with up to 14 lives

Step III: Data analysis

Future work

Step III: Data analysis

Future work

Statistical analysis:

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.

Step III: Data analysis

Statistical analysis

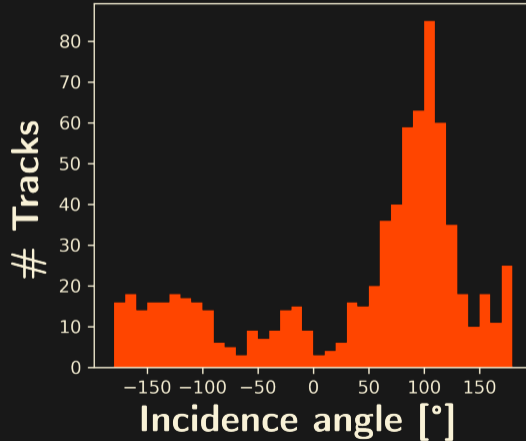


Figure 11: Statistical distribution of incidence angles

Step III: Data analysis

Statistical analysis

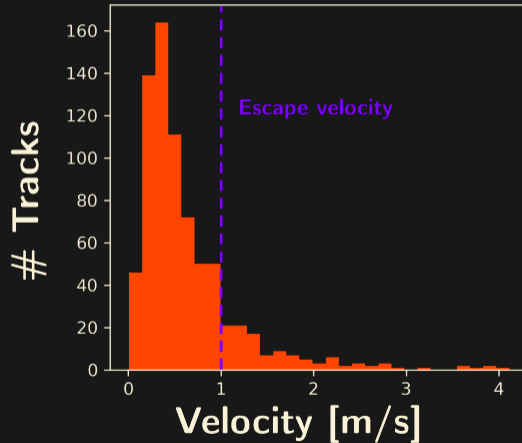


Figure 11: Statistical distribution of mean velocities

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.

Step III: Data analysis

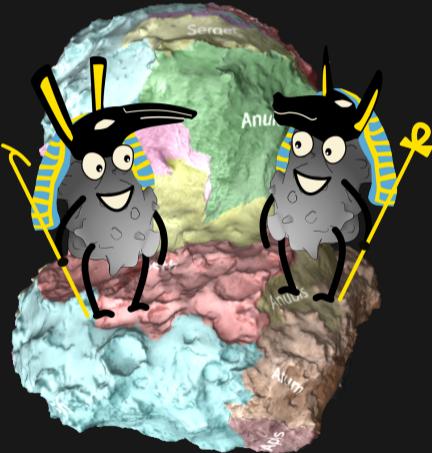
Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ **Place of origin**

Step III: Data analysis

Place of origin



Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ **Fall-back fraction**

Step III: Data analysis

Fall-back fraction

Figure 12: 'Snow fall' on 67P  landru79

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ Fall-back fraction

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ Fall-back fraction

Physical interpretation:

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ Fall-back fraction

Physical interpretation:

- ▶ **Change in direction & acceleration due to exposure to different gas jets**

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ Fall-back fraction

Physical interpretation:

- ▶ Change in direction & acceleration due to exposure to different gas jets
- ▶ **Recoil from asymmetric outgassing**

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ Fall-back fraction

Physical interpretation:

- ▶ Change in direction & acceleration due to exposure to different gas jets
- ▶ Recoil from asymmetric outgassing
- ▶ **Conditions during/for ejection**

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ Fall-back fraction

Physical interpretation:

- ▶ Change in direction & acceleration due to exposure to different gas jets
- ▶ Recoil from asymmetric outgassing
- ▶ Conditions during/for ejection
- ▶ **Significance for entire comet population**

Step III: Data analysis

Future work

Statistical analysis:

- ▶ Incidence angles, velocities, accelerations, etc.
- ▶ Place of origin
- ▶ Fall-back fraction

Physical interpretation:

- ▶ Change in direction & acceleration due to exposure to different gas jets
- ▶ Recoil from asymmetric outgassing
- ▶ Conditions during/for ejection
- ▶ Significance for entire comet population
- ▶ ...

Questions?



Bibliography I

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[//gadgetzz.com/2014/08/10/how-big-is-rosettas-comet-67p/](https://gadgetzz.com/2014/08/10/how-big-is-rosettas-comet-67p/).

Step II: Particle Tracking

Introduction of lives

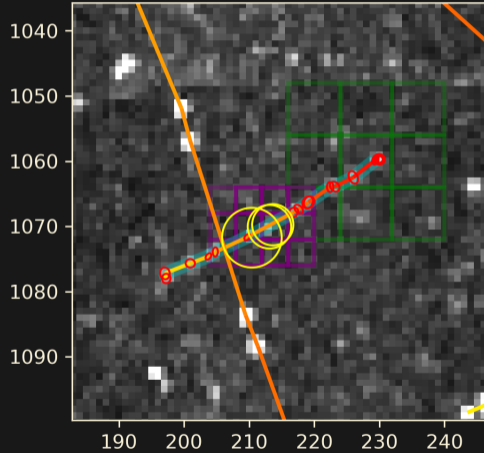


Figure 13: Particle track with missing detections

Step II: Particle Tracking

Introduction of lives

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Step II: Particle Tracking

Sources of error & validation

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Sources of error & validation

Sources of error:

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ **background stars**

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, **cosmic rays**

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, **wrongly connected** / **'stolen' detections**

Step II: Particle Tracking

Sources of error & validation

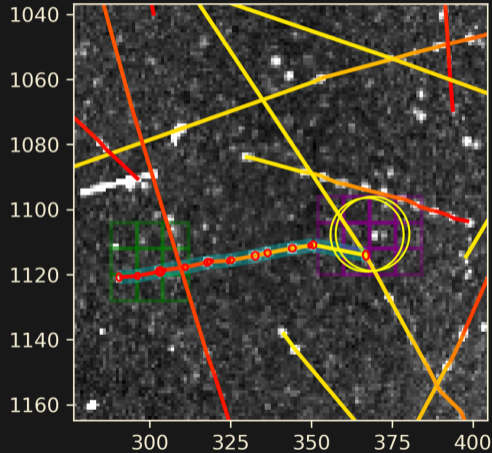


Figure 14: 'Stolen' detection from other track

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections, **false & missing detections**

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections, false & missing detections and **false positives**

Step II: Particle Tracking

Sources of error & validation

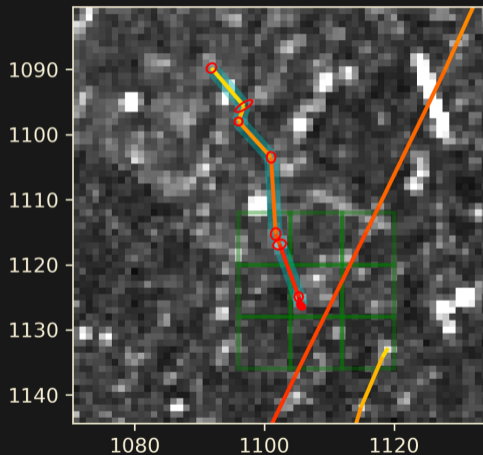


Figure 15: Track generated by noise

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections, false & missing detections and false positives

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections, false & missing detections and false positives

Validation:

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections, false & missing detections and false positives

Validation:

- ▶ Run algorithm on simulated noise

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections, false & missing detections and false positives

Validation:

- ▶ Run algorithm on simulated noise
- ▶ **Run algorithm on simulated data**

Step II: Particle Tracking

Sources of error & validation

Sources of error:

- ▶ background stars, cosmic rays, wrongly connected / 'stolen' detections, false & missing detections and false positives

Validation:

- ▶ Run algorithm on simulated noise
- ▶ Run algorithm on simulated data
- ▶ **Evaluate choice of free parameters**

Step II: Particle Tracking

Sources of error & validation

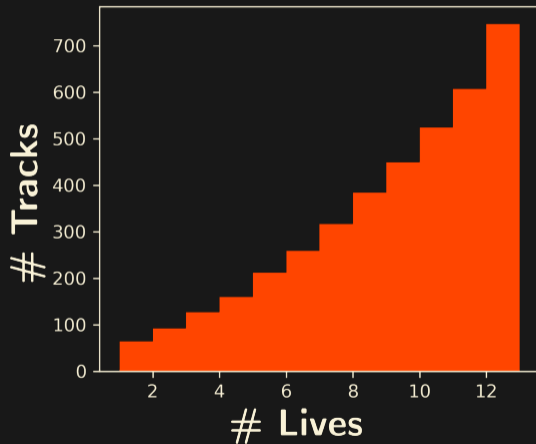


Figure 16: Evaluation of free parameters

Step II: Particle Tracking

Sources of error & validation

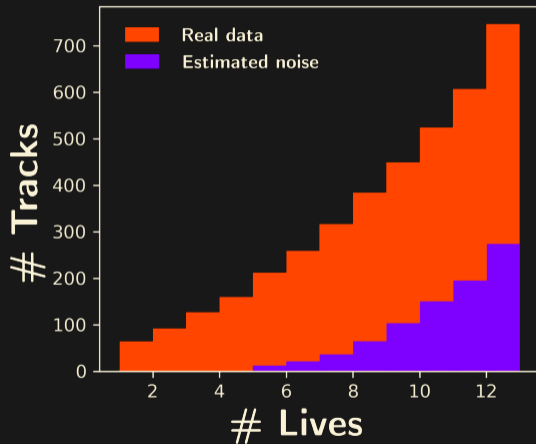


Figure 16: Evaluation of free parameters