Polarimetric Observations of the nucleus of comet 67P/Churyumov-Gerasimenco, the target of Rosetta Mission.

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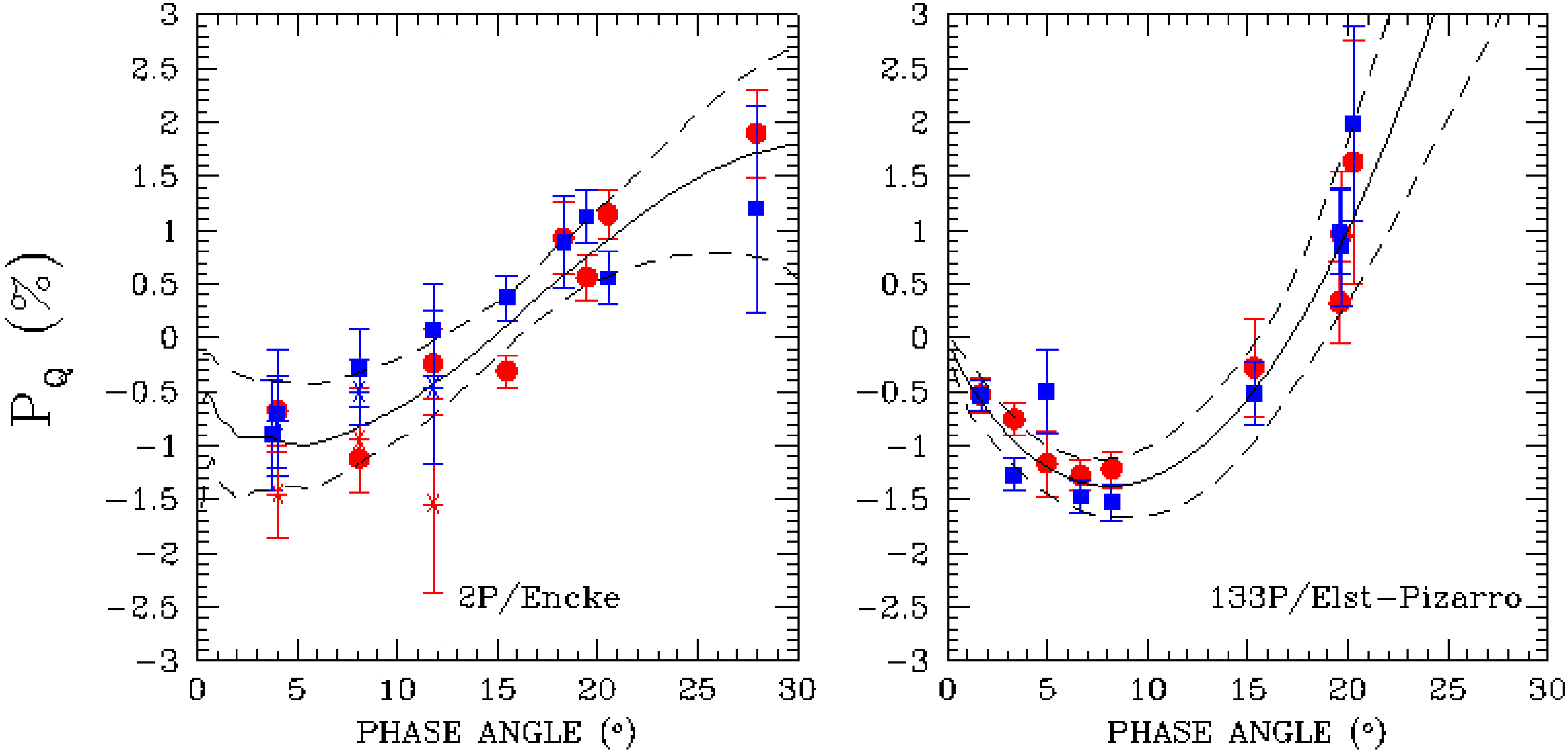
Introduction

- Cometary Nucleus are very difficult to study because they are small and often hidden by cometary coma.
- They are very well studied only with space missions, but only 8 nucleus visited so far.
- When comet are at large heliocentric distance (>3 AU), i.e. presumably without coma the nuclues appears very faint.

Why Polarimetry?

- Photometric measurements of distant cometary nuclei can give only data on their size (S) multipied the geometrical albedo (A).
- To know the size it is necessary to know *A*, that can be deduced with contemporary observations in the thermal IR.
- Polarimetric observations at different scattering angles can can provide information on the properties of the surfaces on a microscopic and global scale

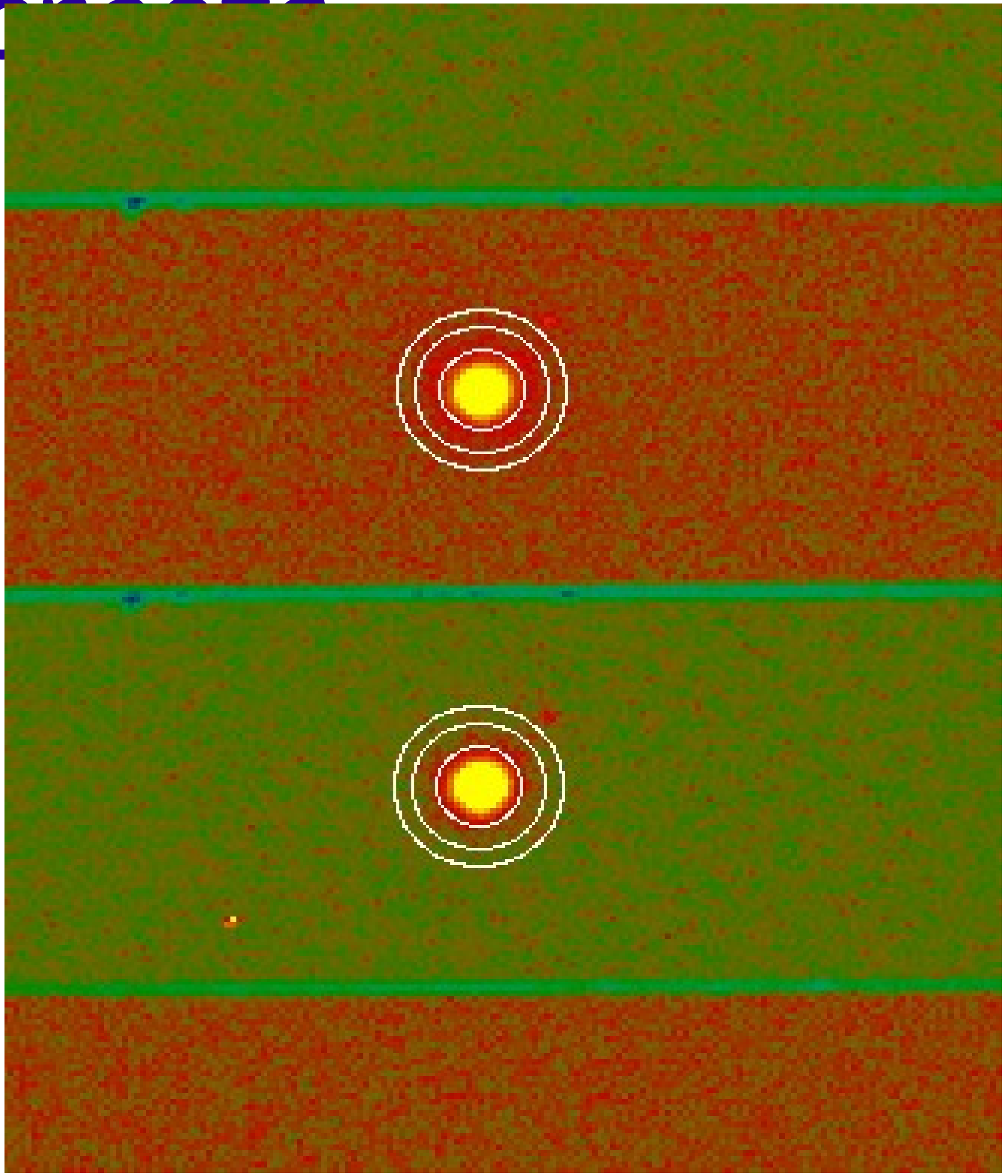
Cometary nuclei



Why 67P/Chryumov-Gerasimenco?

- It is the target of the *Rosetta* Mission. In May 2014 the comet will be reached by the probe.
- It was well placed, with phase angles changing from 3.7° to 15.4°, when the comet was outbound, at rh > 3.4 AU, i.e. presumably without coma

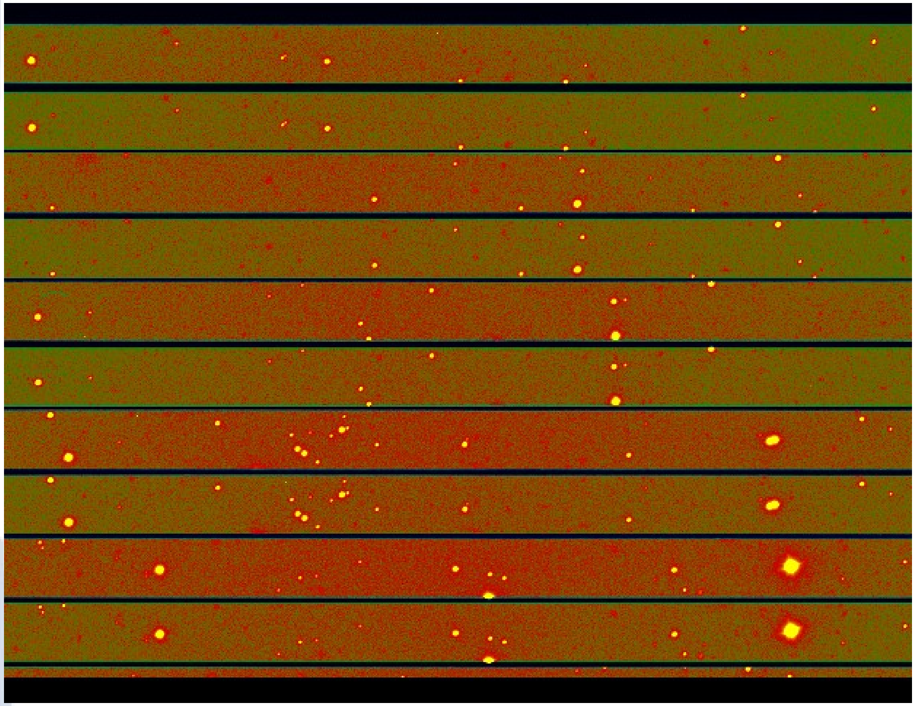
Data reduction method for bright targets

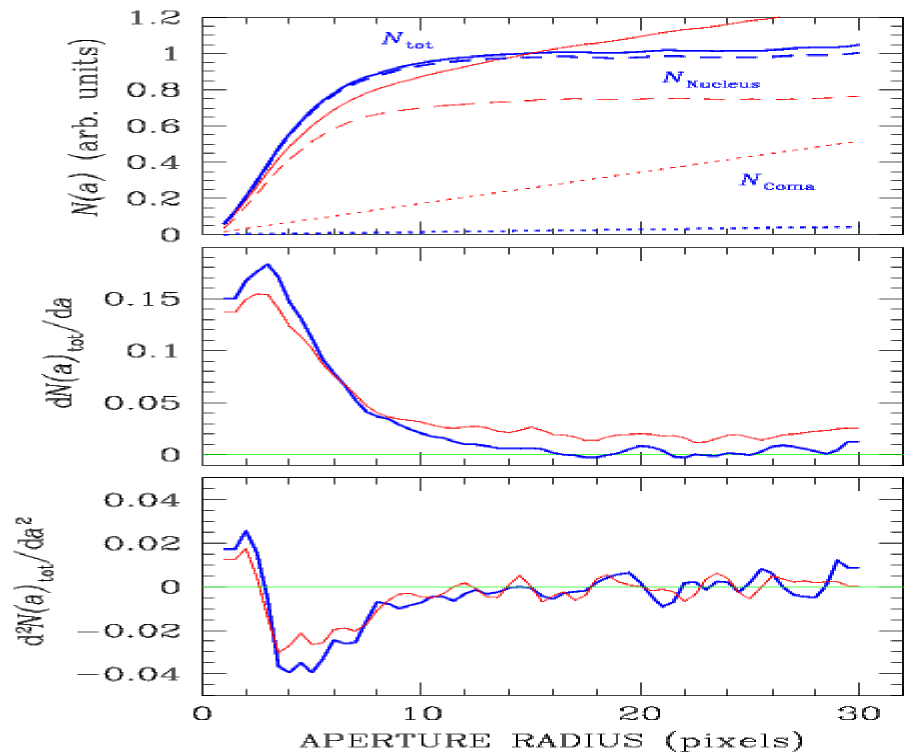


- We have plenty of photons and the sky background low.
- The main source of errors is the photon noise

Method for faint targets

- The photons are very limited and the sky background can be very high.
- The sources of errors are the photon noise and the sky background.
- In this case it is necessary to find the best aperture, to have the maximum signal and the minimum sky contribution
- SB & GPT have developed a "Stokes curve of grow", to select the best aperture. We plot (Iex-Ior)/(Iex+Ior) in function of the aperture.

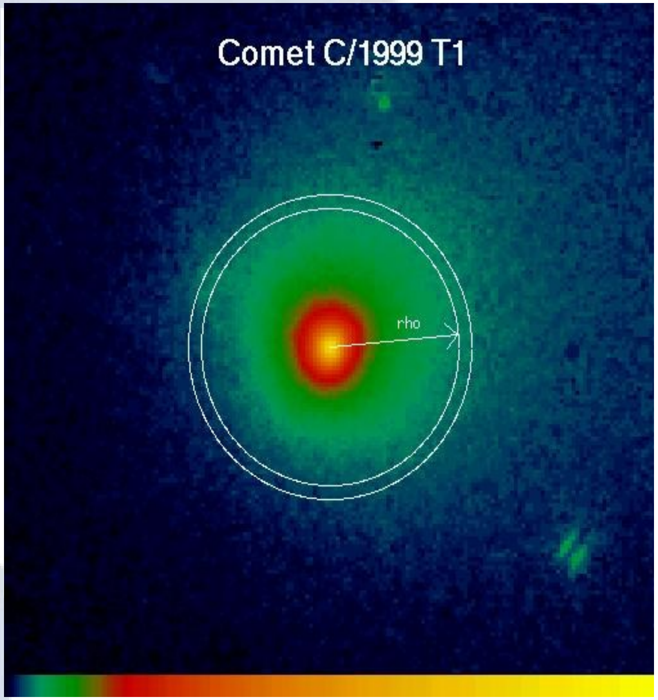


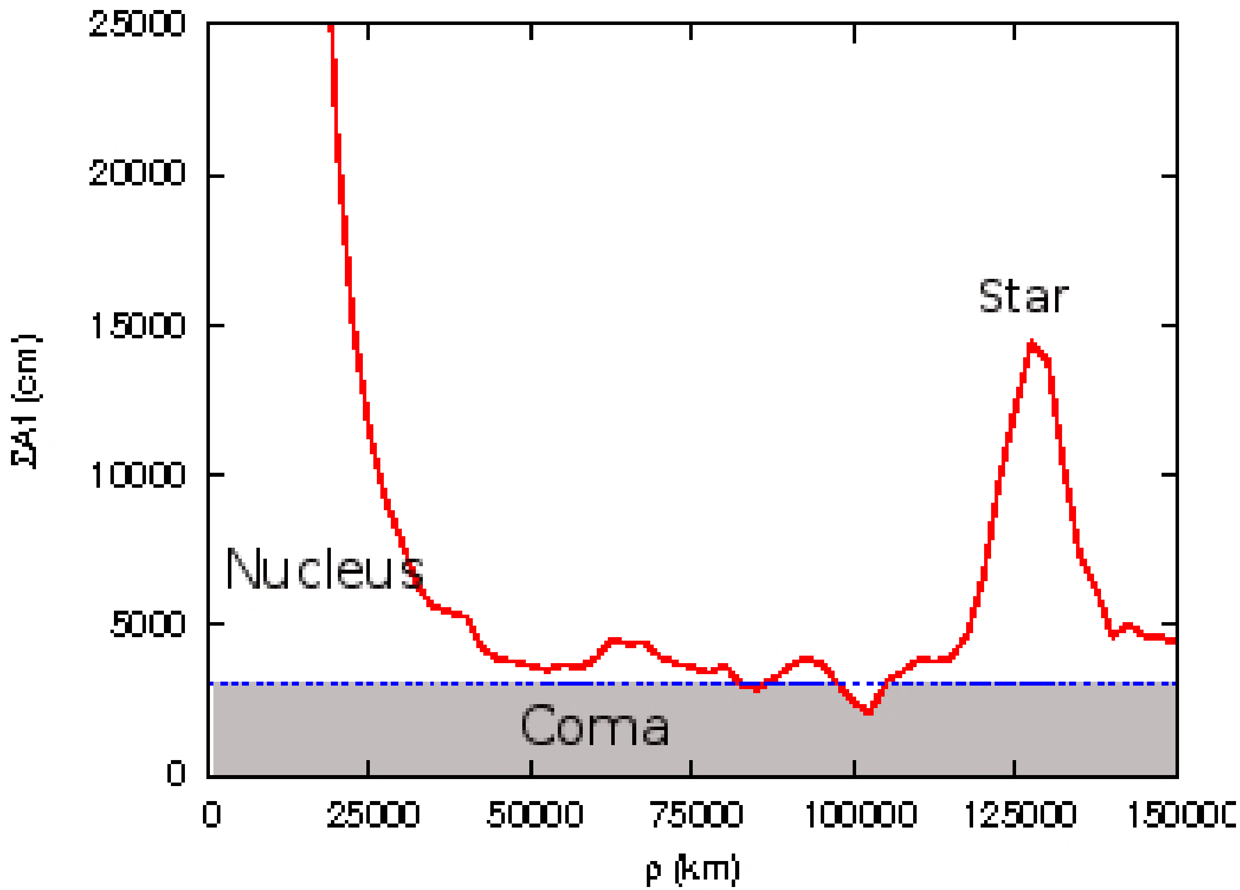


N_{tot}
$N_{Nucleus}$
N_{Coma}
N(a) (arb. units)
dN(a)$_{tot}$/da
d^{2}N(a)$_{tot}$/da^2
APERTURE RADIUS (pixels)

Faint targets with coma

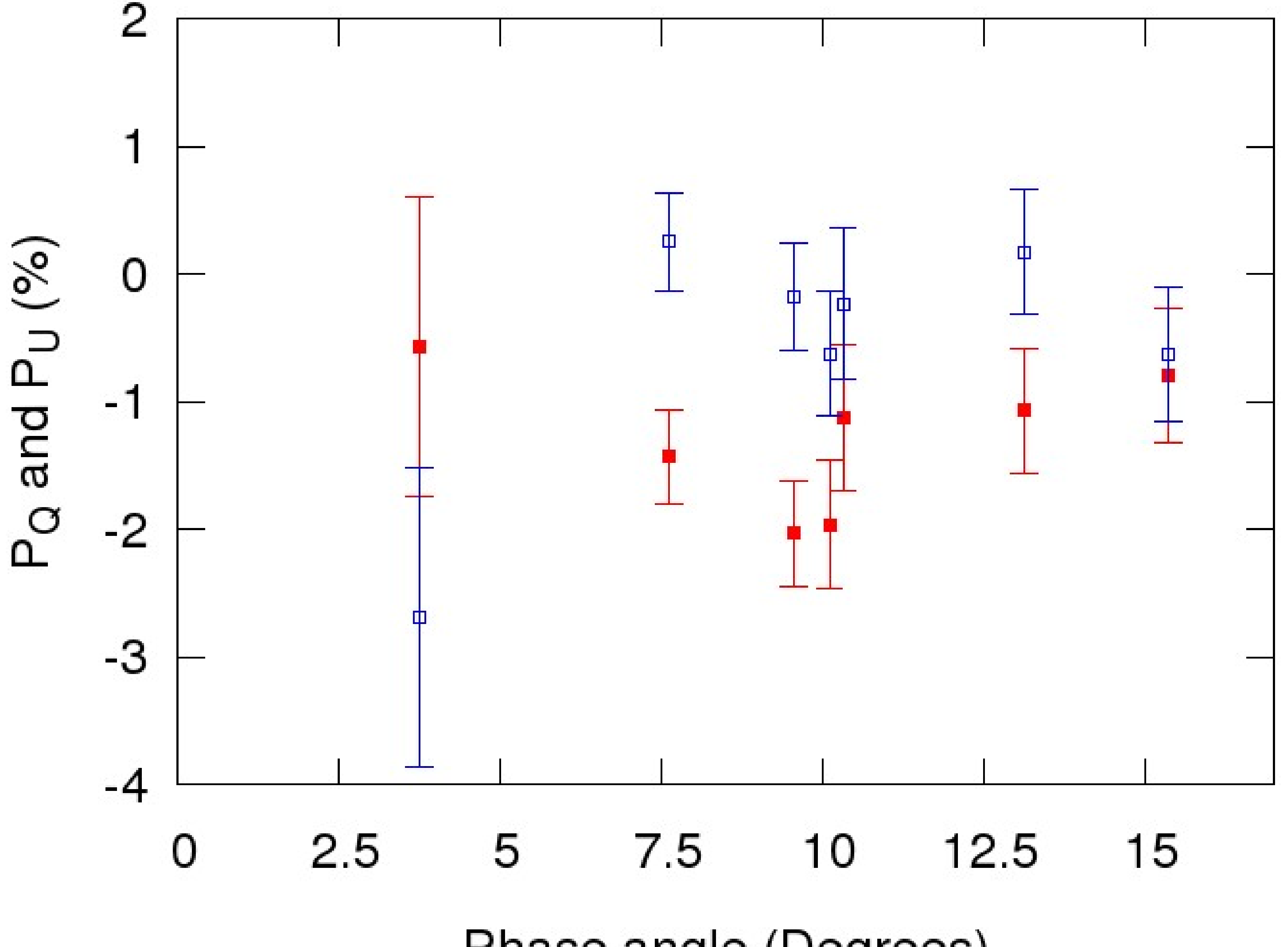
- Usually the coma in distant comets is due to dust
- In principle, for "normal comet" the column density **(N_bar(ρ))** of dust is going as **1/ρ**, with ρ the projected nucleocentric distance.
- To evaluate coma contribution we use the **ΣAf(ρ)** function, that is equal to **2πρAf(ρ)**. With *A* the geometrica albedo of the dust and f its filling factor.
- **ΣAf(ρ) is constant with ρ and the contribution of the nucleus is close to ρ = 0**
- **Polarimetric images have limited FoV**


Comet C/1999 T1
rho


25000
20000
15000
10000
5000
0
ΣA1 (cm)
Nucleus
Star
Coma
0
25000
50000
75000
100000
125000
150000
ρ (km)

Results of 67P as point source

- During all the observations the comet was outbound at $r_h > 3.4$ AU and no coma was visible.
- So, the Stokes parameters have been measured in the classical way, for faint source.
- Results



2
1
0
-1
-2
-3
-4
0
2.5
5
7.5
10
12.5
15
P_Q and P_U (%)
Phase angle (Degrees)

Tail in 67P

- By adding all the acquisition images a tail showed up.
- A tail is not a coma, and its ΣAf is **not** constant
- By fitting the ΣAf, excluding the nucleus signature, we can evaluate the contribution of the tail to nucleus
- The results are that within 4000 km the tail contribute by 74%
- The influence of the tail in classical measurements (sky in an annulus) can be as high as 50%.
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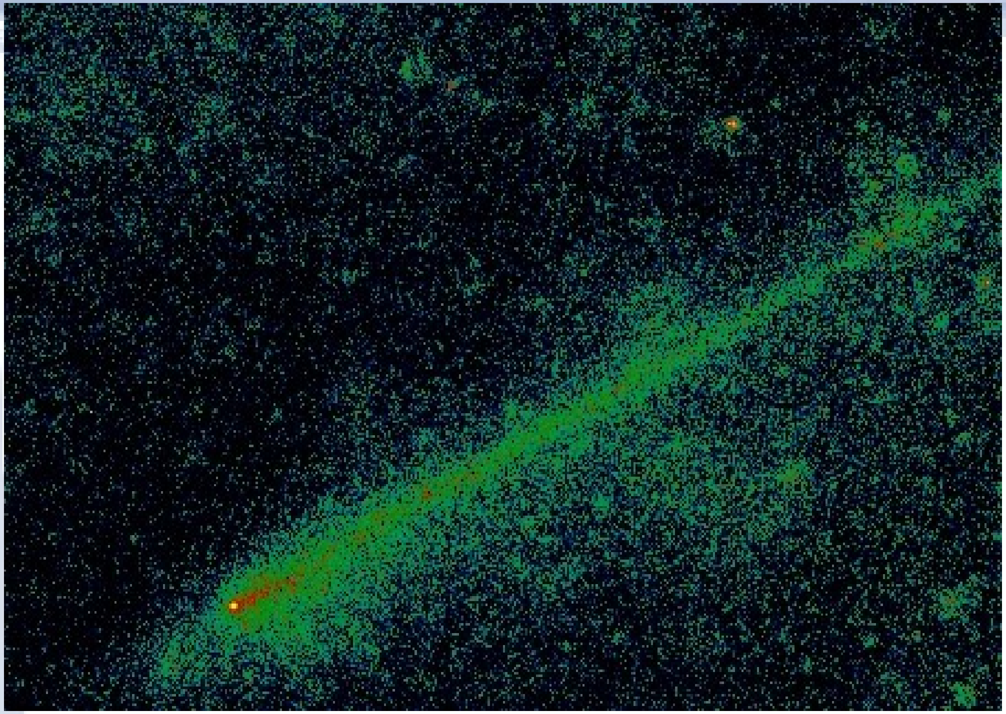
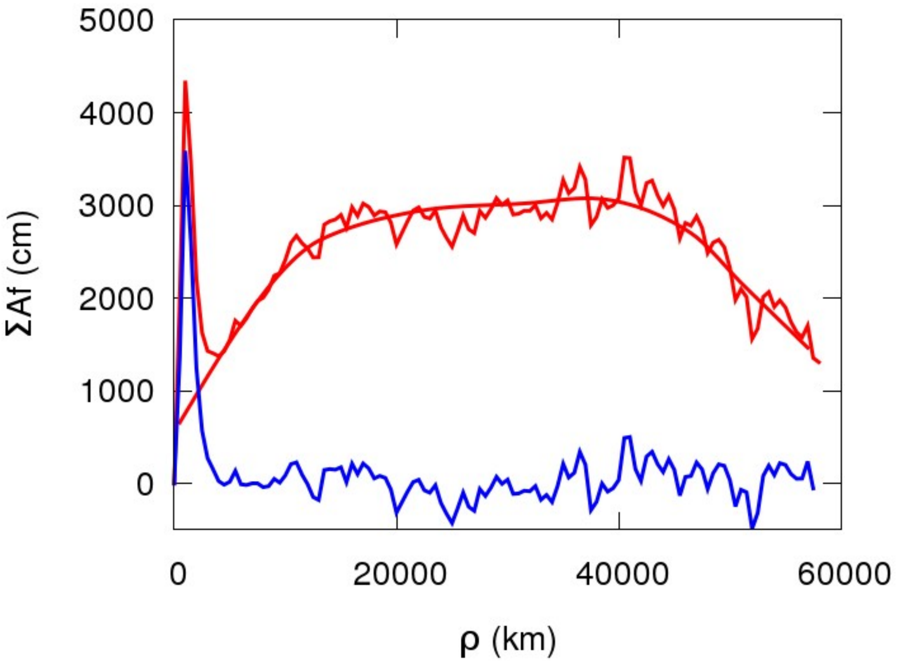
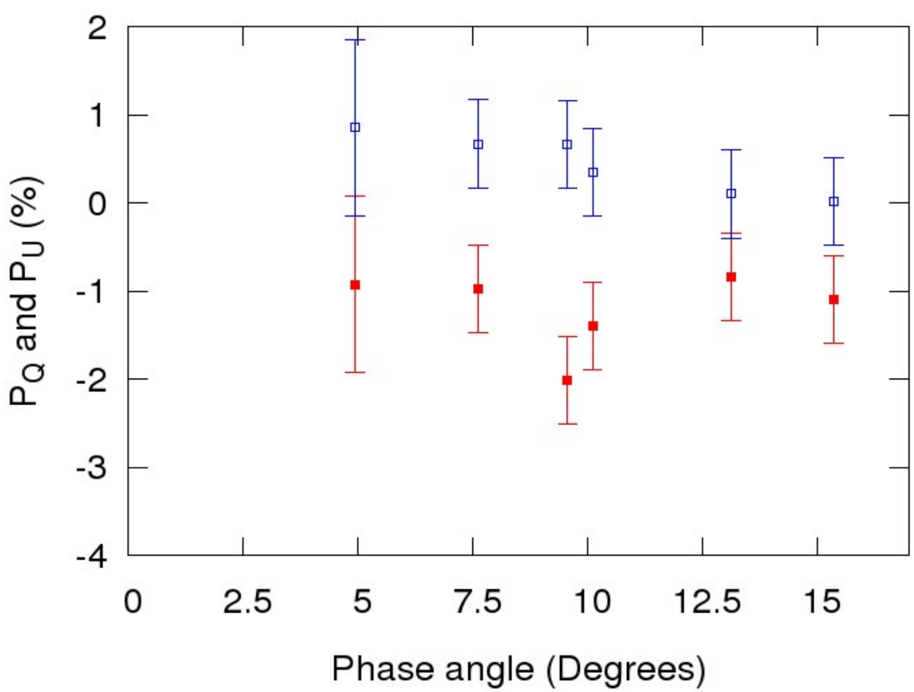


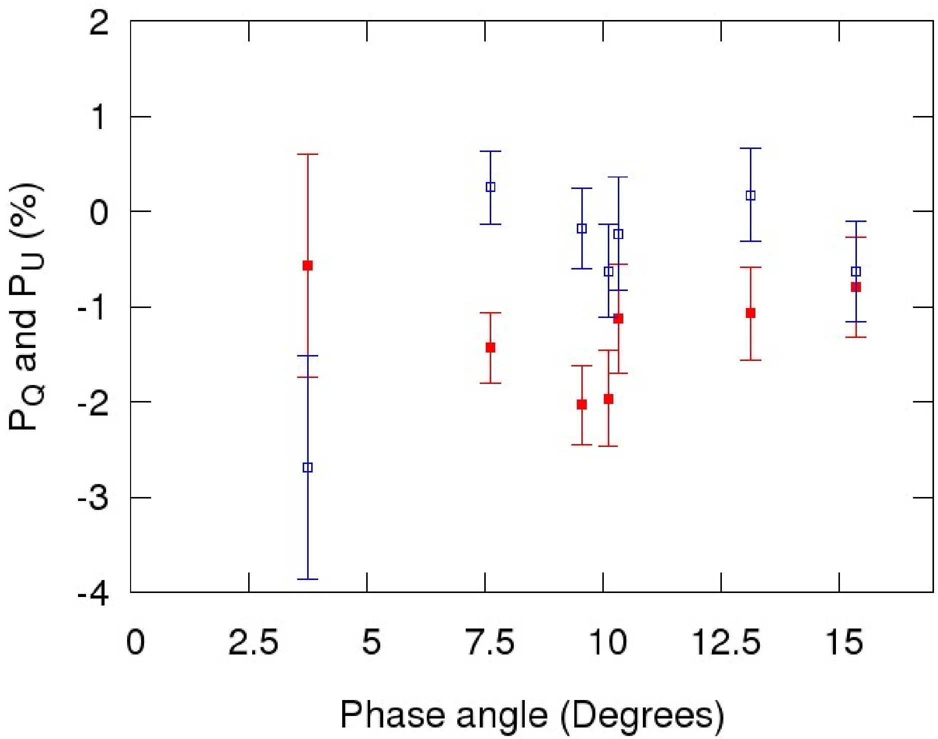


5000
4000
3000
2000
1000
0
ΣAf (cm)
0
20000
40000
60000
ρ (km)

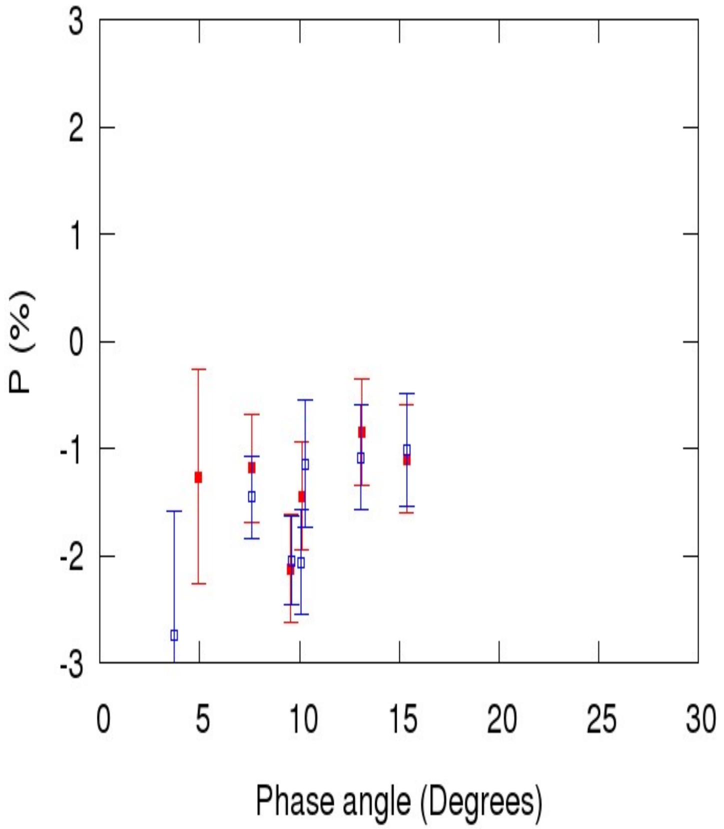
Results

- The Stokes parameters have been carefully re-measured by taking into account of the tail.

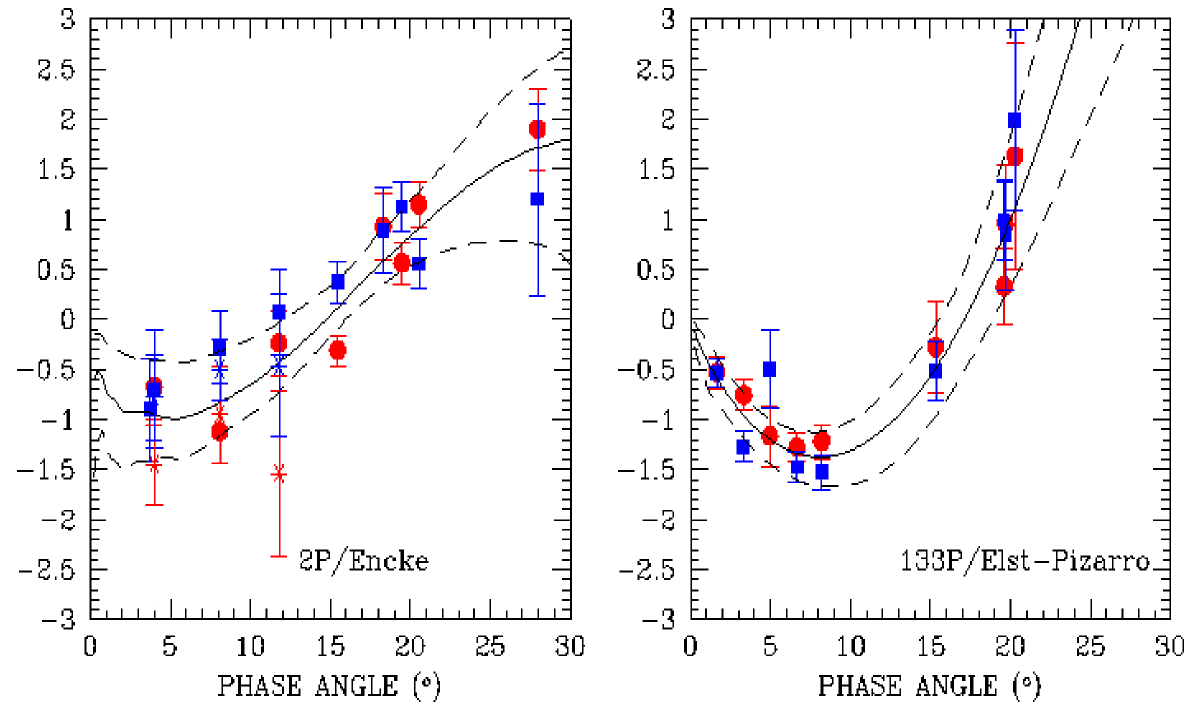




Results



P (%)
Phase angle (Degrees)



2P/Encke
PHASE ANGLE (°)
133P/Elst-Pizarro
PHASE ANGLE (°)

Conclusion

- Unfortunately the errors and the limited phase angles of the measurements don't allow firm conclusions
- The fact that the Stokes parameters measured as "point" source and taking into account of the coma are very close, means that che dust of the tail has the same polarimetric characteristics of the nucleus.