

# Space Safety

The background of the slide is a dark, space-themed image. It features a grid of faint, light-colored lines that create a perspective effect, suggesting a tunnel or a path through space. On the right side, there is a large, curved structure composed of many small, colorful particles (blue, purple, green) that resemble a satellite or a space station. A bright, glowing blue light source is visible in the distance, illuminating the scene and creating a lens flare effect.

Prof. Maciej Konacki



# Space debris

5 980

number of  
rocket  
launches

5 900

number of  
satellites  
still in  
space

10 280

number of  
satellites  
placed into  
Earth orbit

3 200

number of  
satellites  
still  
functioning

27 830

number of  
catalogued  
space debris

> 550

estimated number  
of collisions

> 9 000 ton

total mass of all space  
objects in Earth orbit

estimated number of debris objects in orbit

34 000

> 10 cm

900 000

1 cm - 10 cm

128 000 000

1 mm - 1 cm

Source: ESA, 18 November 2020





# Debris impact effects

Probability of the collision of a LEO satellite (cross section of 10 m<sup>2</sup>) with space debris 0.1–1 cm in 10 years of the satellite's operation is close to one.

Al sphere diameter: 1.2 cm

Al sphere mass: about 1.7 g

Impact crater diameter: 9.0 cm

Impact crater depth: 5.3 cm

Speed: 6.8 km/s

Al block width: 18 cm

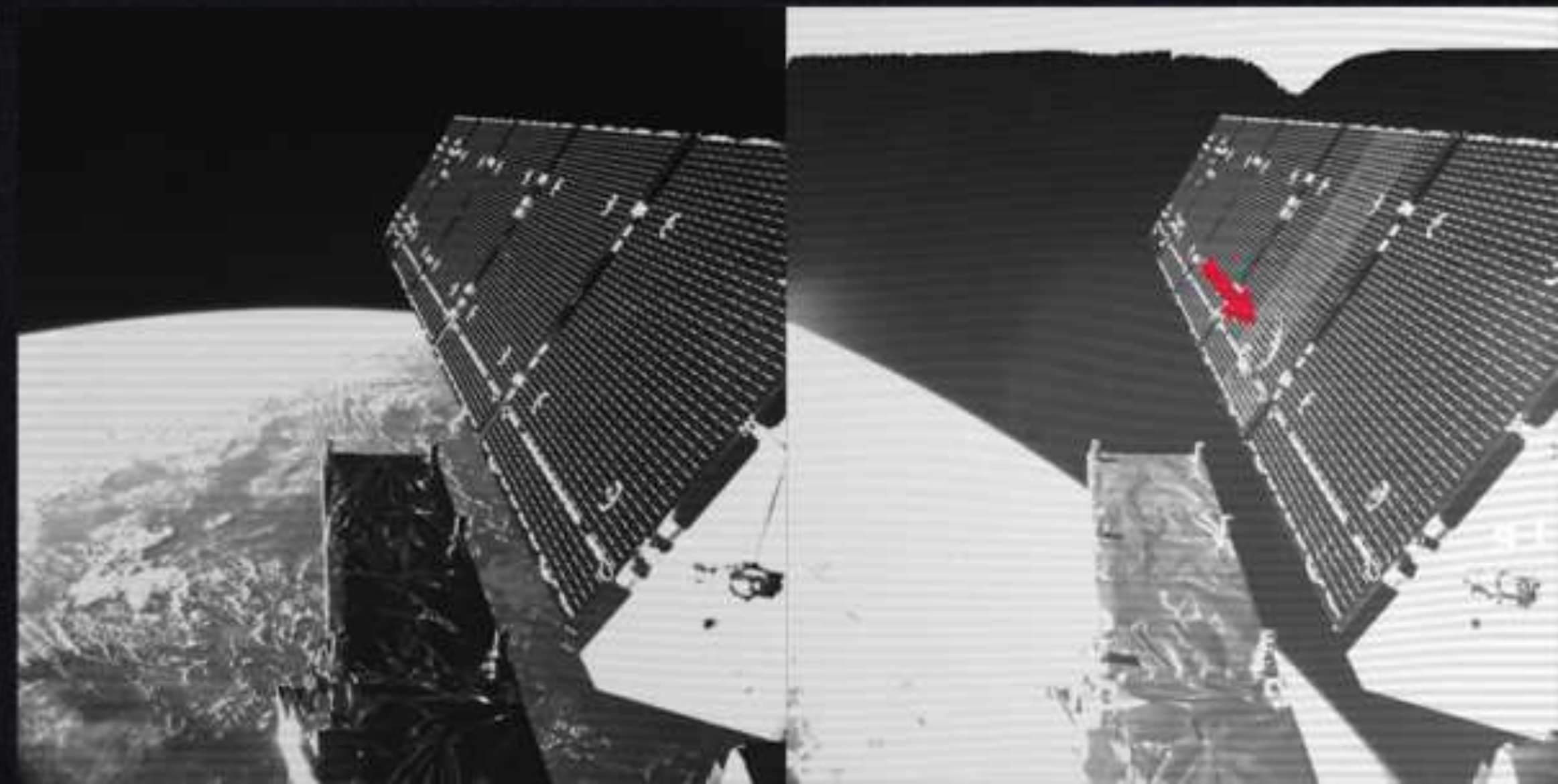
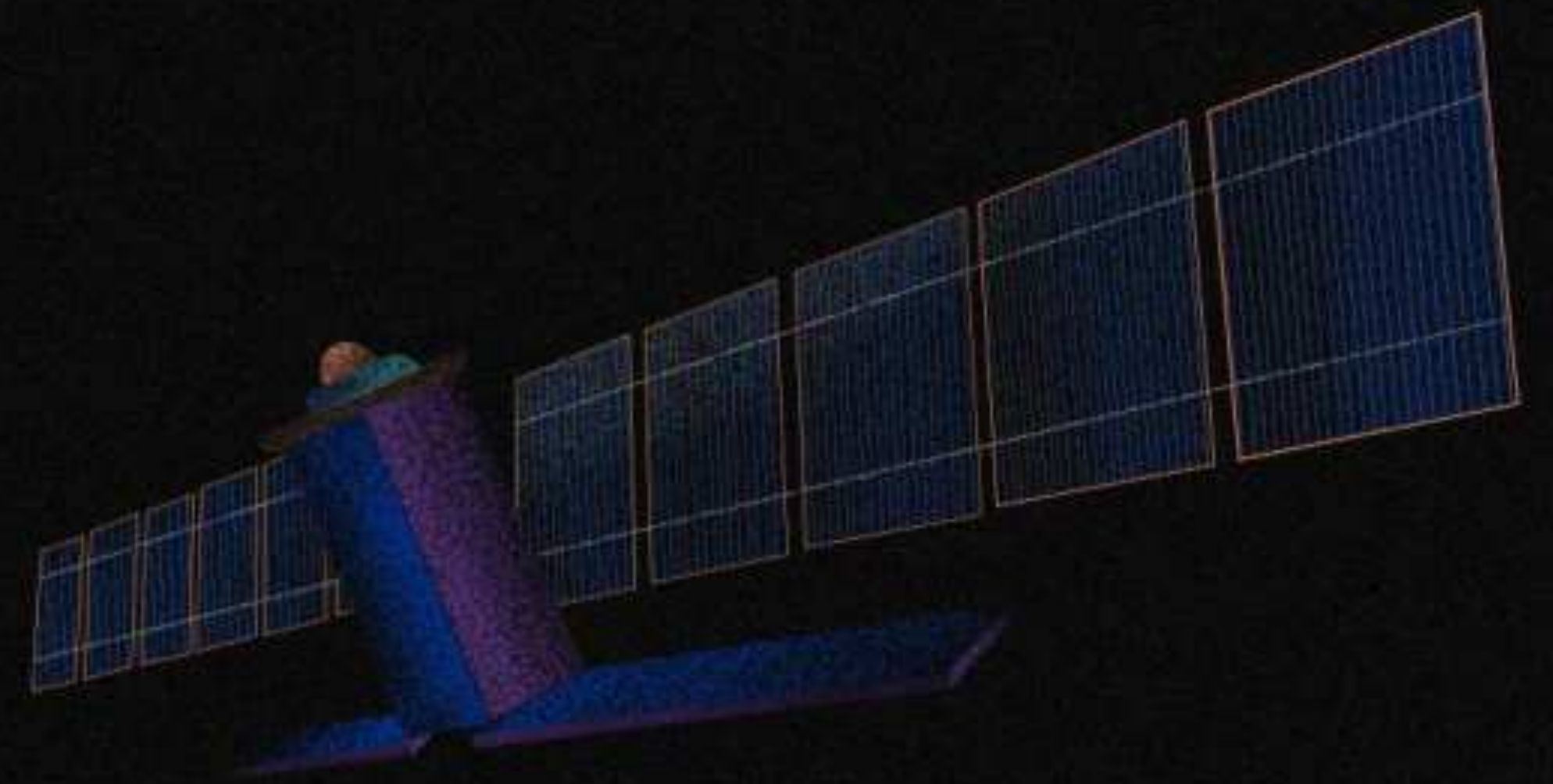




# Collision of Sentinel-1 satellite with space debris

The picture shows Sentinel-1A's solar array before and after the impact of a 5 millimetre size particle on the second panel. The damaged area has a diameter of about 40 cm.

Source: ESA





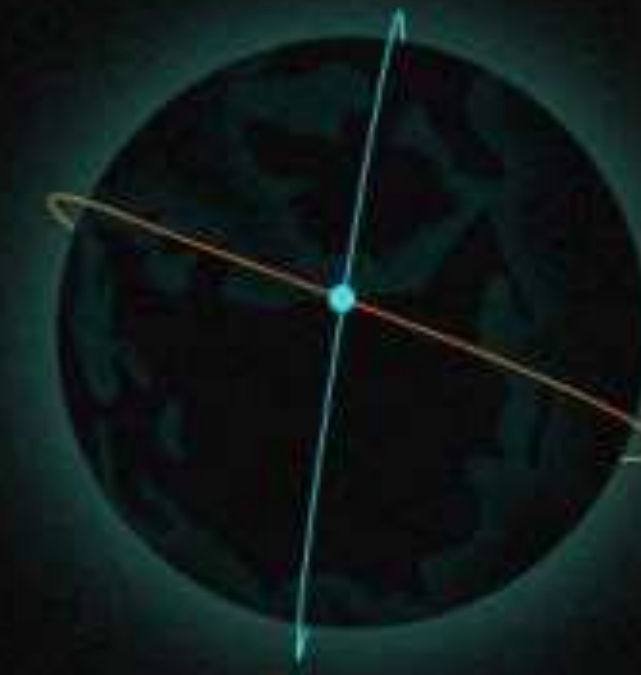
# Collisions in orbit

Collision of two communication satellites:  
**Iridium 33** (active, 560 kg) and  
**Kosmos-2251** (debris, 950 kg)

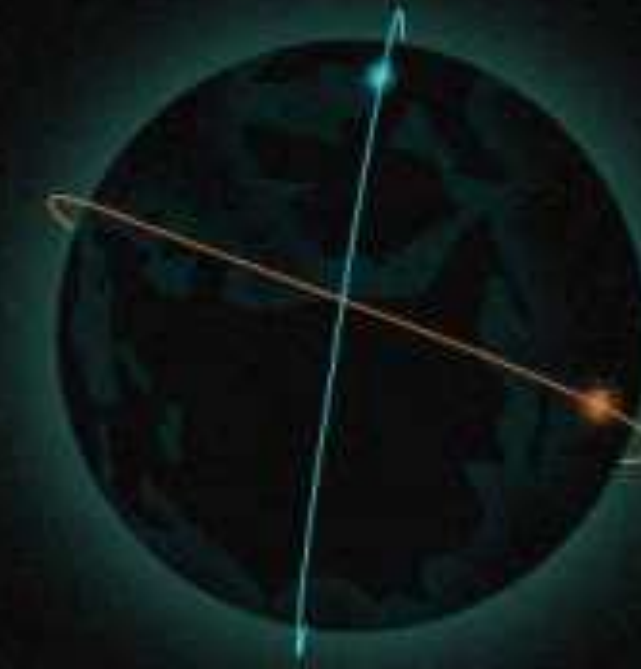
Speed of collision 42 000 km/h, altitude 790 km

10 February 2009, > 2000 new space debris

- Iridium 33
- Kosmos-2251



point of  
collision



debris fields  
after 10 minutes



debris fields  
after 3 hours

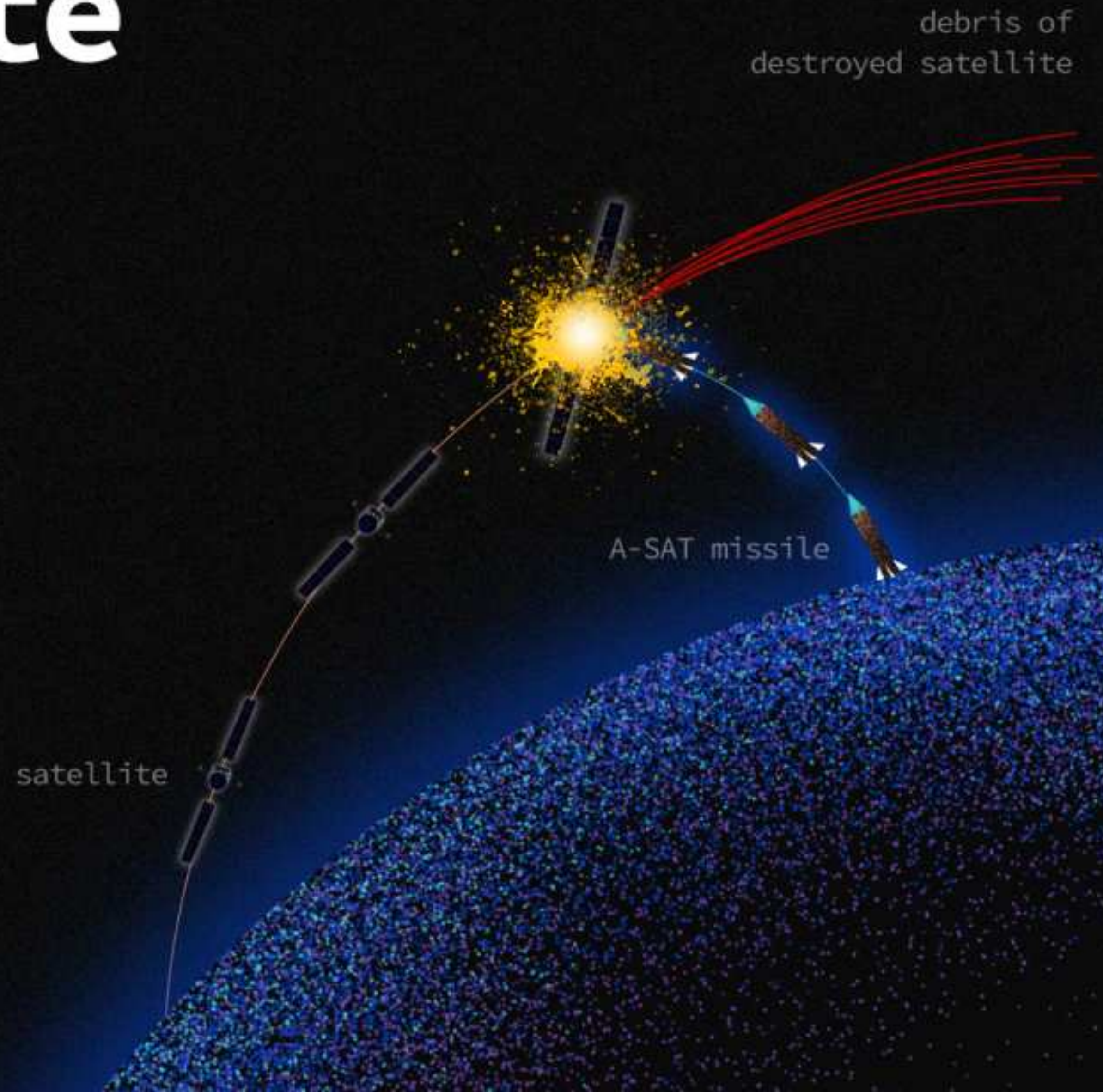


# Anti-satellite weapons

Tests taken since late 50' of the XX century, US, USSR/Russia

Documented destruction of satellites by A-SAT weapon:

- US: September 1985, February 2008
- China: January 2007
- India: March 2019





# Fragmentation in orbit

GEO Telkom-1 satellite fragmentation,  
Indonesia, 25 August 2018

Temporary malfunction of ATMs  
and payment terminals

Source: ExoAnalytic Solutions

ExoAnalytic  
SOLUTIONS





11 May 2020

# Reentry Of 18-ton Chinese Rocket Stage



Source: EUSST





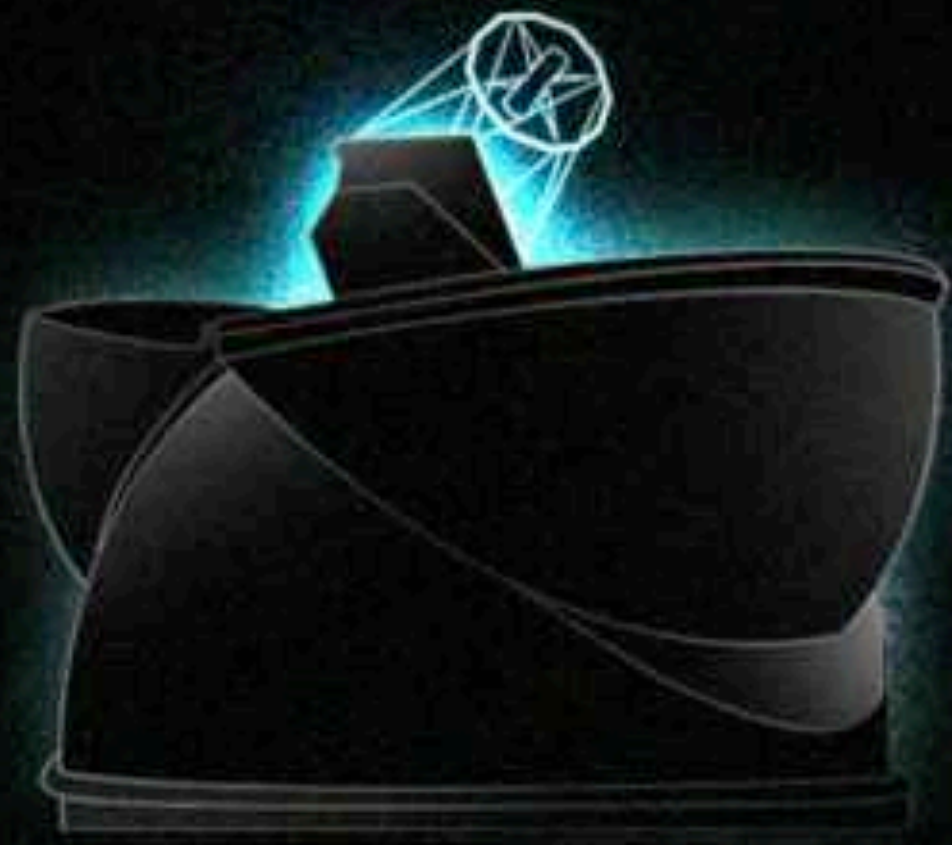
# Kessler Syndrom

Collisions create more debris creating a runaway  
chain reaction of collisions and more debris





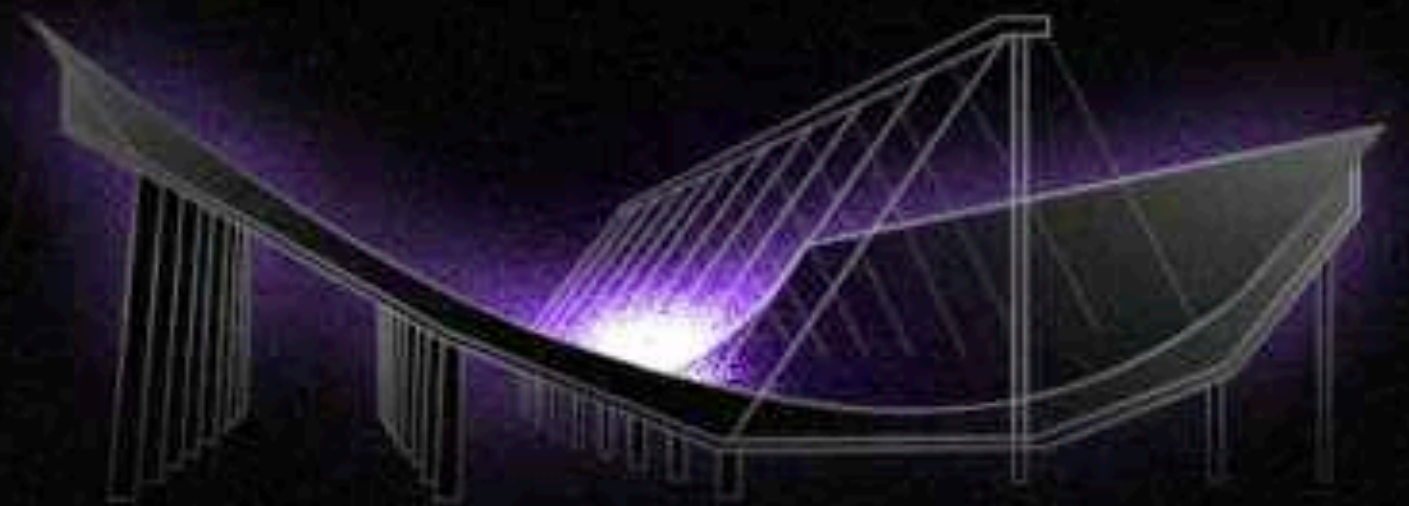
# Observational techniques



optical



laser



radar



# SSA National Network Sensors

Solaris-1 and 2, NCAC PAS, SA



● South African  
Astronomical  
Observatory





# Optical observations

Solaris-3B, NCAC PAS, Eastern Australia

- LEO satellite
- 600 km above the Earth, orbital period 100 minutes
- 200 images, 1 minute 40 seconds
- Field of view 1.7 x 1.4 degrees





# 5 meters away from a collision between Polish satellite BRITE2-PL and a debris

In December 2019 an old rocket stage missed a Polish scientific satellite BRITE2-PL by 5 meters

