

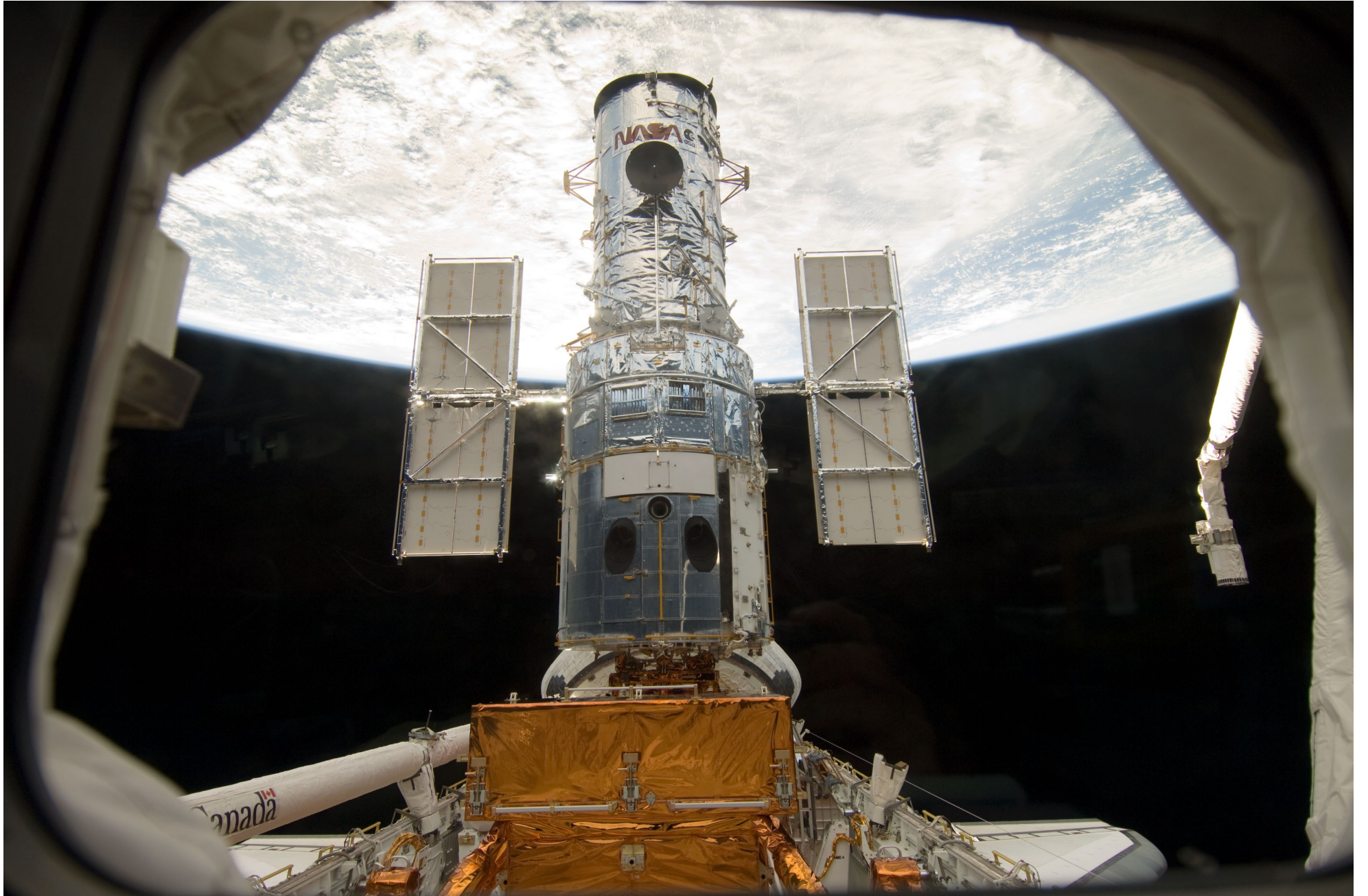
A photograph of an astronaut in a white space suit floating in space. The astronaut is positioned on the left side of the frame, with their body angled towards the right. The background is filled with a dense field of orbital debris, including various pieces of metal, plastic, and other spacecraft components. The Earth's blue and white atmosphere is visible in the lower right portion of the image. The text "An Astronomer Nitpicks GRAVITY" is overlaid in the upper left quadrant in a light blue, sans-serif font.

**An Astronomer Nitpicks  
GRAVITY**

**Jonathan McDowell**

Here are some of the real spaceships you will see...

The movie does a great job of reproducing them accurately











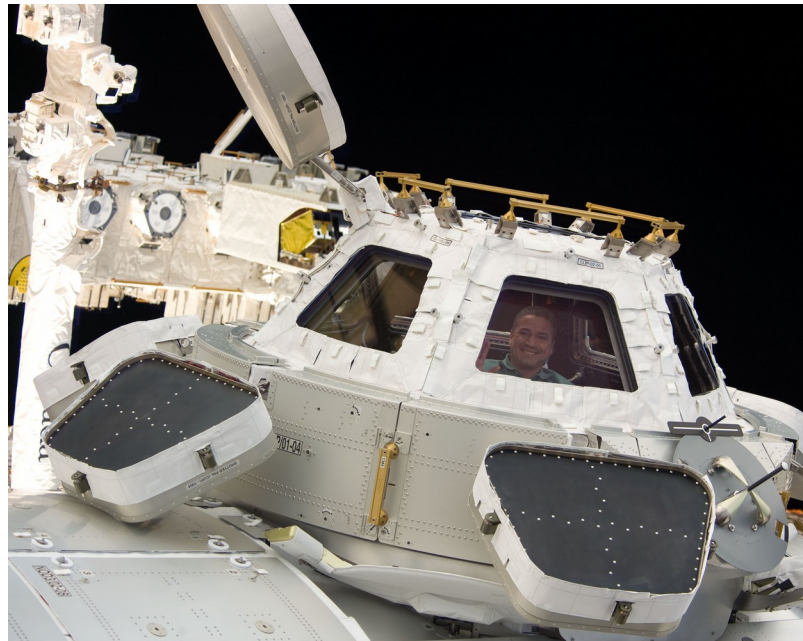


S104E5125 2001/07/16 11:06:24



ISS026E012169



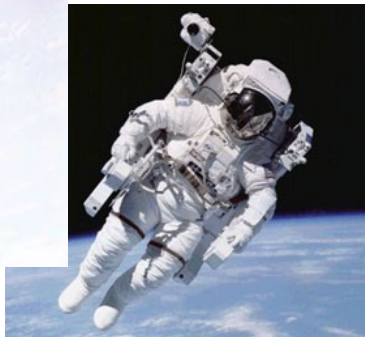


ISS022E068726



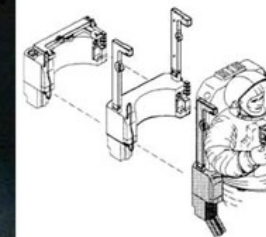
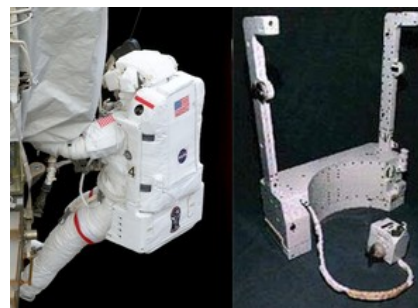
# FUTURE HISTORY

Jul 21, 2011: STS-135 lands and ends the Shuttle program



MMU

SAFER



In the movie, we are at mission STS-157

We must assume that President Trump has restarted the Shuttle production lines and persuaded ESA to build new ATV cargo ships.

What happened in the intervening 22 Shuttle missions?

- The ISS orbit has been raised from 400 to 600 km

- There's a new module on ISS at Node 2 zenith

- A robotic spacecraft was used to change the Hubble telescope's orbital inclination and rendezvous it with ISS

- In a detente move, the new Chinese space station has been assembled co-orbiting with ISS

- The MMU backpacks retired in 1985 (in favor of the much smaller SAFER backpacks) have been taken out of the museum and returned to flight (and improved to have a lot of extra propellant)

# Chinese station in 'Gravity'



China's planned space station, which needs its new mega-rocket Long March 5 – whose first launch is coming in a few months



天宮一號與神舟九號首次手控交會對接  
特別報道 標尺中心對準靶標 開始最後靠攏  
從天宮會神九

CRI online 新聞 國際在綫

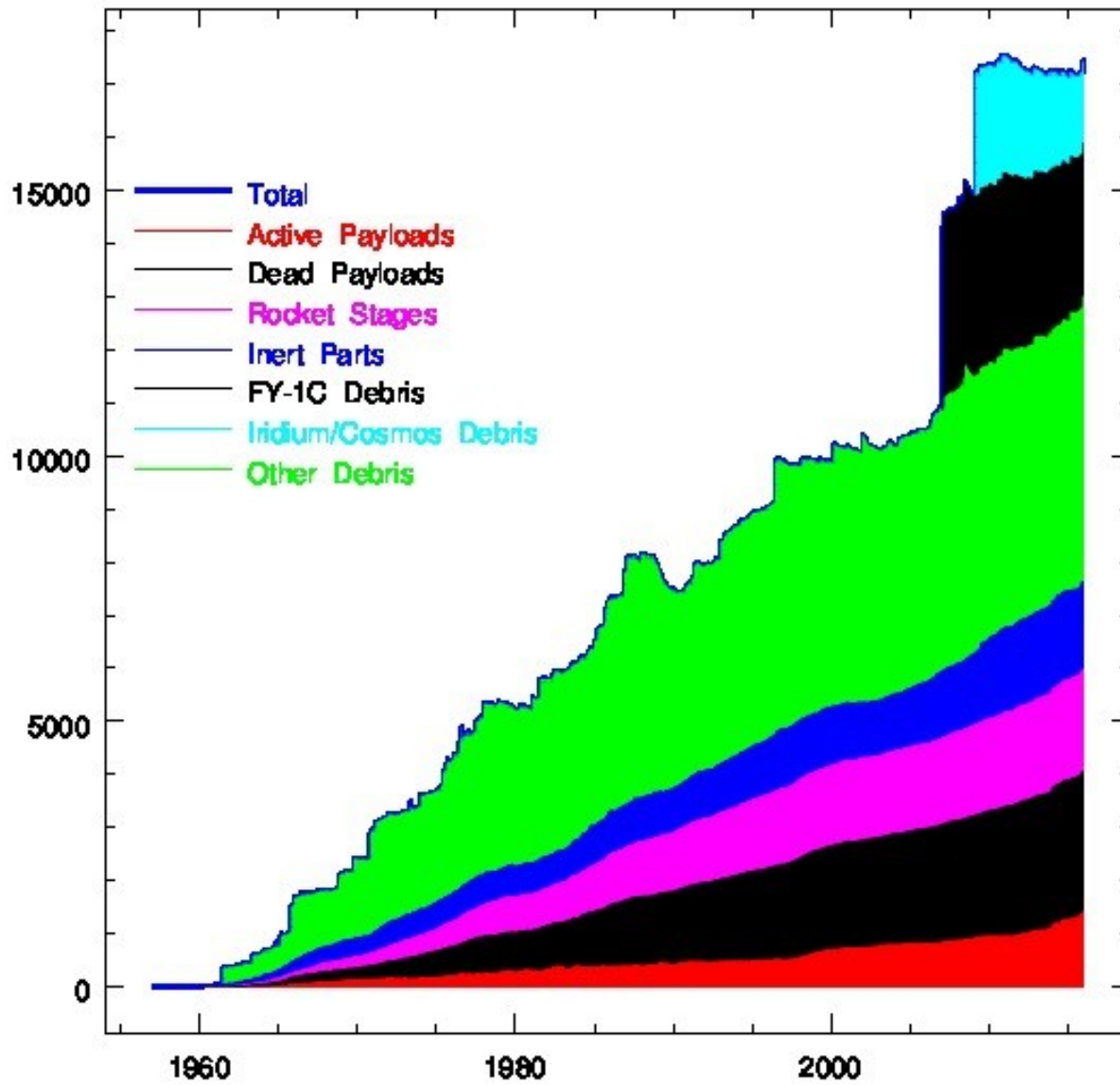
天宮艙內

Tiangong-1, the mini-station China has today



How realistic is the debris event depicted in Gravity?





The amount of orbital debris has rocketed up in recent years



Why is the cloud of debris so dense? Why does it intersect ISS orbit every 90 min?

Movie says Russian weapons test hit something and caused a chain reaction.

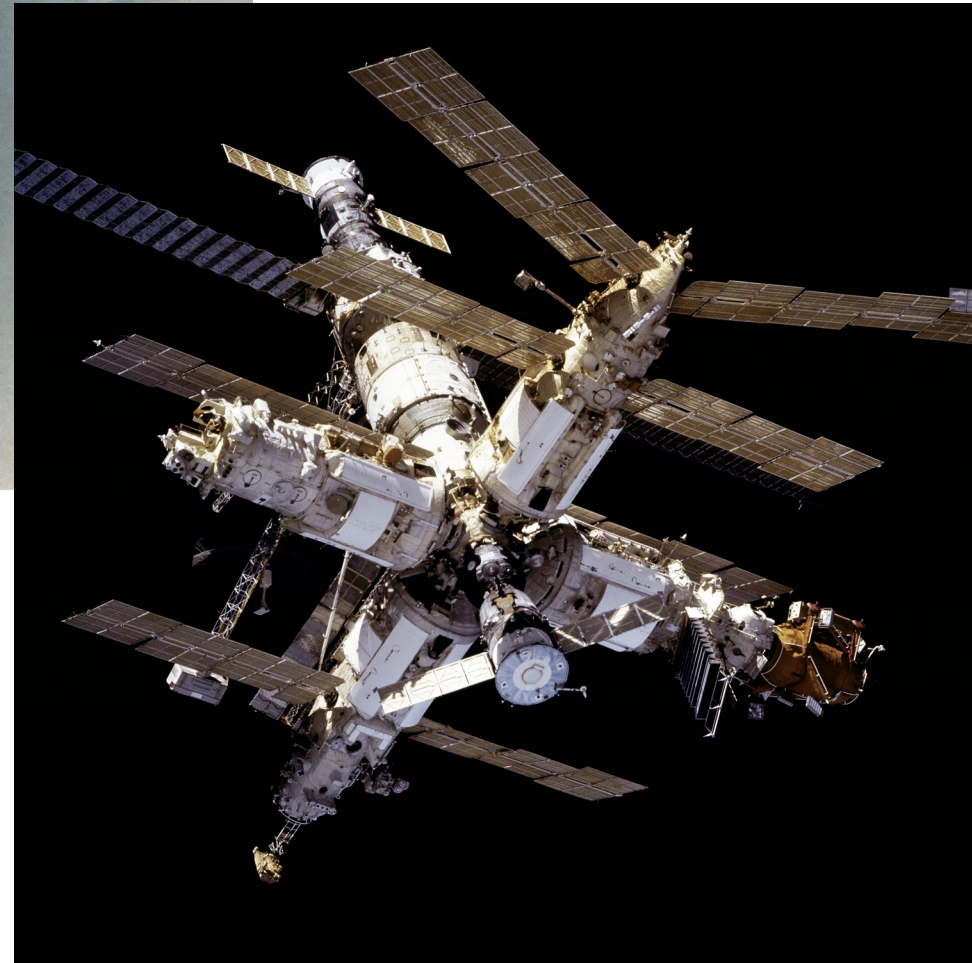
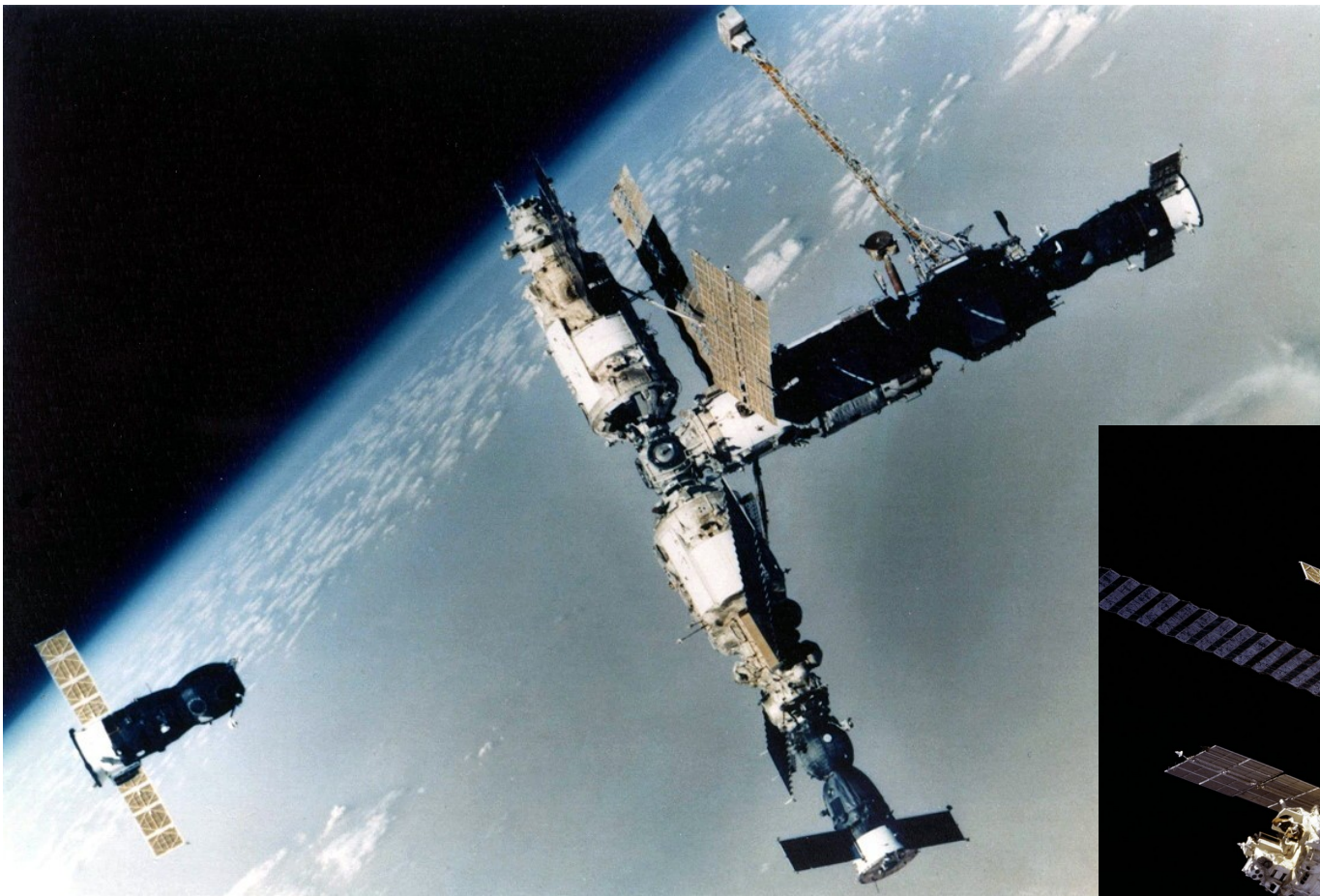
Unlikely to get a chain reaction so fast.

What would give a dense cloud near ISS?.

Most plausible: debris hits an arriving cargo ship, already in an orbit whose velocity is similar to ISS. A 15 tonne ship (like Japan's HTV) would create a lot of debris in an orbit that repeatedly intersects the station

Wouldn't knock out communications satellites though – they are 23000 miles high, far above the 250 mile height of the International Space Station

Here's an older space station: Mir (1986-2001) with an arriving ferry ship



A real "bad day" in space - Jun 25, 1997

Vasily Tsibliev remotely joysticks the Progress M-34 cargo ship in towards a docking with the Mir space station

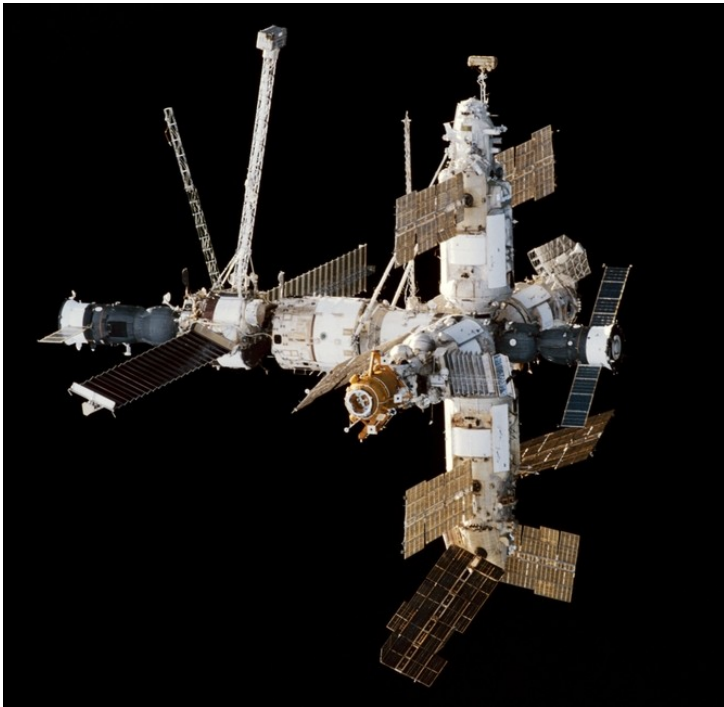
He has no radar data, only the poor TV images seen below. Can you spot the Mir station in the bottom left pic?



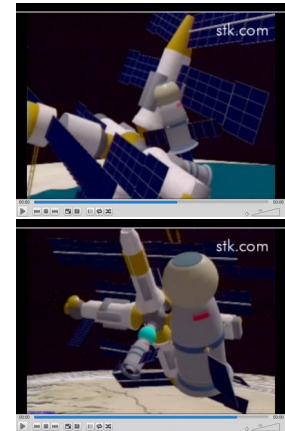
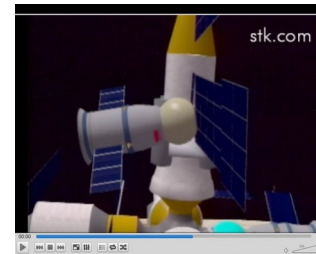
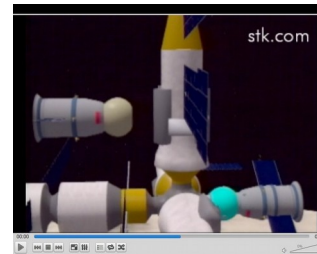
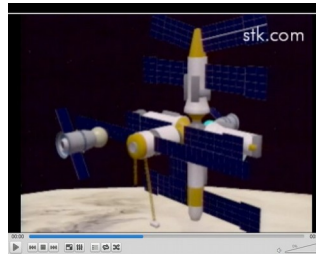


# A real “bad day” in space

Jun 25 1997 – Progress M-34 crashes into the Mir space station



“I heard a big bang ... [and] felt the pressure drop in my ears. The depressurization alarm went off..”

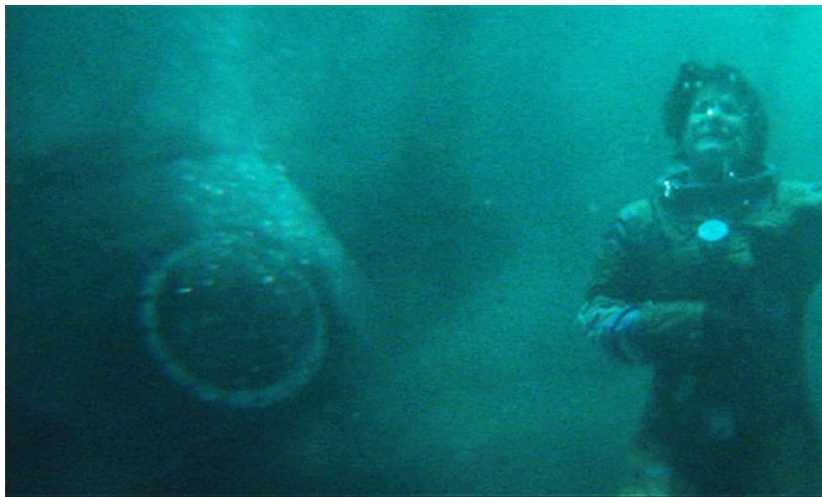


The hatch to the Spektr module stayed closed for the remaining 4 years of the Mir station's life – vacuum on the other side

## Another Bad Day in Space

### The Sinking Spaceship

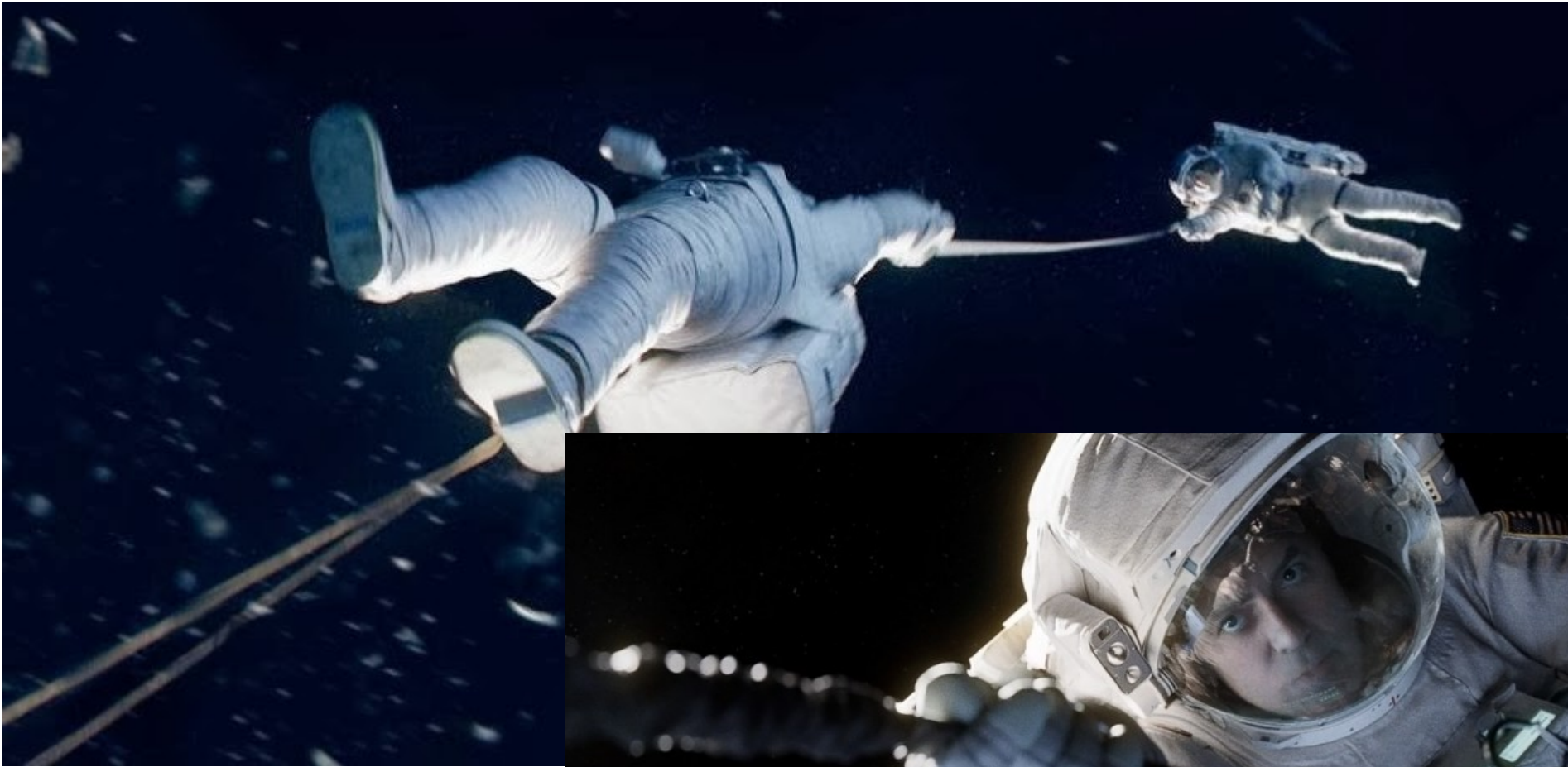
- this really happened to Gus Grissom's Mercury capsule -  
Gus escaped just before it sank in 1961  
Recovered from the ocean floor in 1999



“THAT'S NOT HOW ANY OF THIS WORKS.....”

A FEW PIECES OF QUESTIONABLE PHYSICS AND ASTRONAUTICS

Why does Clooney get tugged away from Bullock?



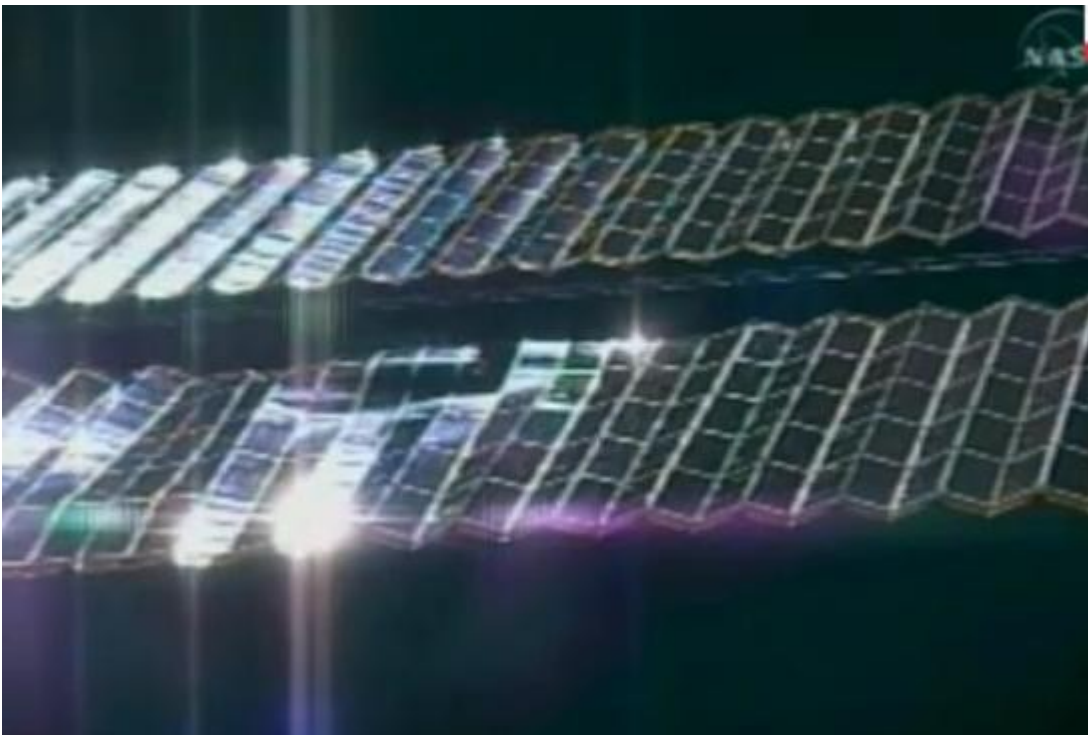


Air venting from the broken space station acts like a rocket to push it, and Bullock, away from Clooney!

Admittedly, when Clooney lets go, Bullock seems to be spring back towards the station, which makes no sense.

## OTHER PHYSICS ISSUES:

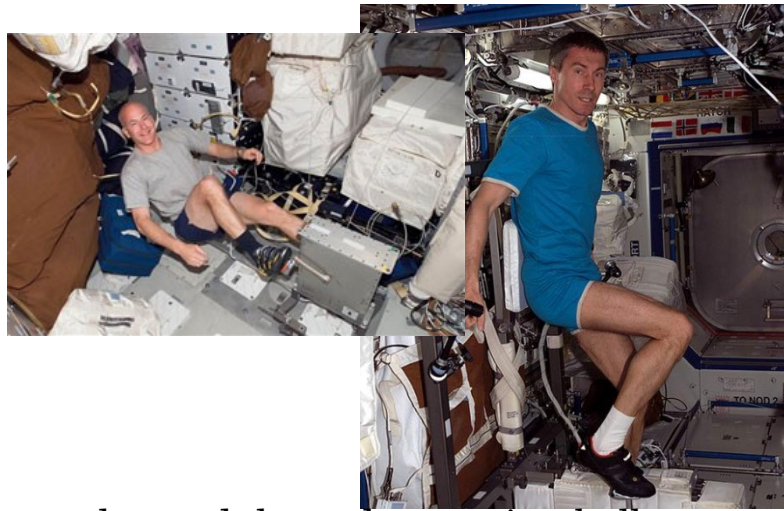
- Bullock flies the Soyuz descent module to Tiangong, using only the soft landing thrusters. I'm skeptical they have enough thrust, and certain that she couldn't aim it correctly
- When she opens the ISS – and Tiangong – hatches from outside, they swing open pretty hard due to the air rushing out. You're meant to dump the airlock air first. When someone made this mistake on Mir he broke the hatch hinges and they had to use another airlock for the next few years.
- The solar panels are flexible, they'd wiggle a lot when stuff crashes into the station
- Humans aren't that flexible, Bullock and Clooney would break bones when smashing into the station as their tethers flail around



Bullock is wearing only underwear under her spacesuit. It's true that when not doing spacewalks the astros often float around ISS in not much more than that



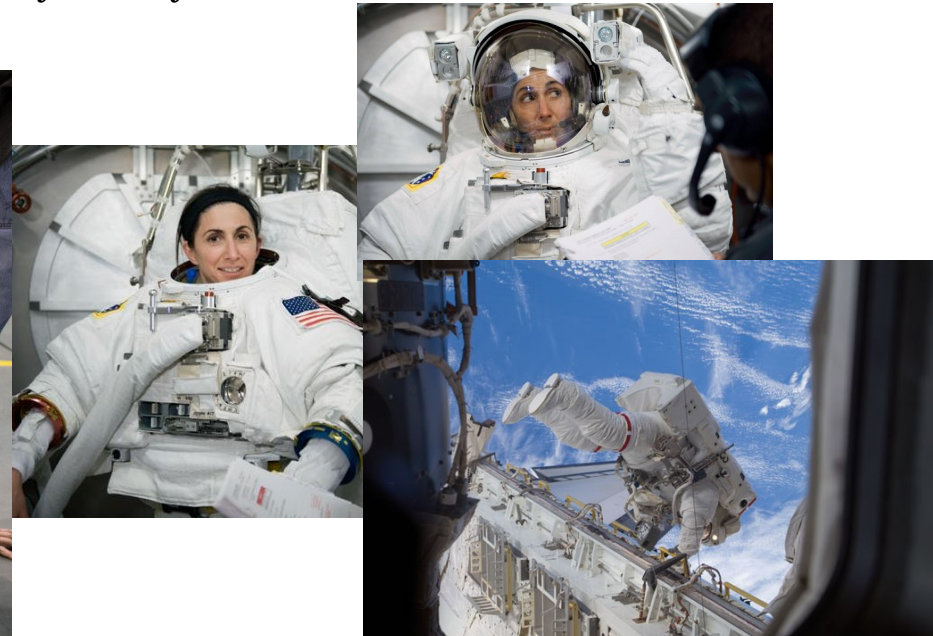
Sandra Bullock, "Gravity"



Nicole Passonno Stott  
Spacewalk 2 Sep 2009

But when they wear a spacesuit, between that and the underwear is a bulky 'Liquid Cooling Ventilation Garment' with water running through it – not nearly so form-fitting.

And – it takes a LOT longer to get out of your spacesuit, especially when you don't have help from another crewmember



S128E00729

## ASTRONAUTS BEHAVING BADLY

**LEARN YOUR TETHER PROTOCOL!!** “Make before break”

As soon as Bullock catches on to ISS she should attach a tether and 'mountaineer' across ISS, attaching one tether before releasing previous one, instead of just trying to leap from one bit of ISS to another! The astronauts in “The Martian” also make this mistake (plus, she should have a SAFER backpack in case of emergency)



Also, as NDGT pointed out, test pilot Clooney lectures medical doctor Bullock on the effects of oxygen deprivation. Seems to me, though, that's totally realistic test-pilot mansplaining.



