



# XRISM Reveals Changing Accretion-Driven Winds in a Nearby Active Galaxy

NGC 4151

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XRISM

# Active accreting Supermassive Black Hole: A tiny engine reshapes an entire galaxy

Host Galaxy

Black hole

**1 in 10 billion**

black hole size vs. galaxy size

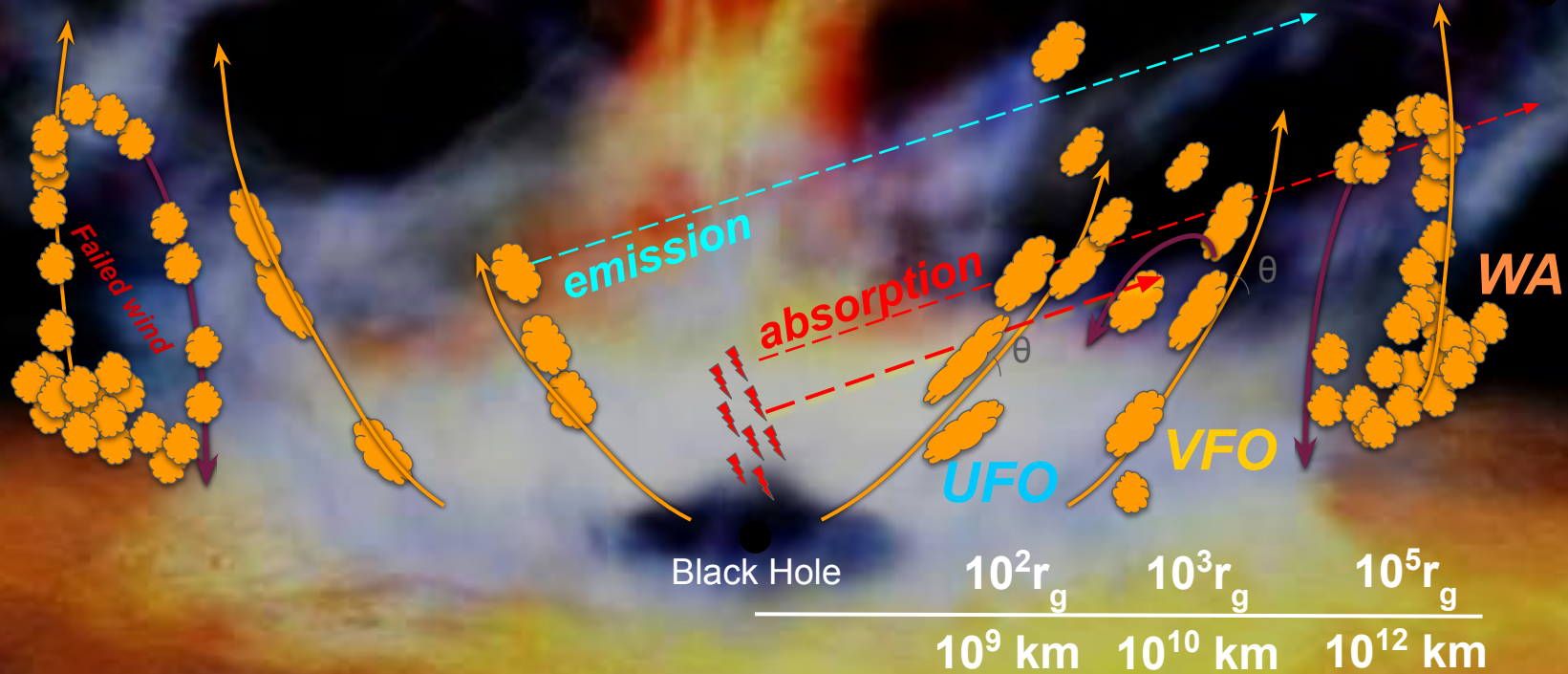
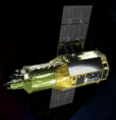
**100×**

Energy released vs. gravitational binding energy of the galaxy bulge

**0.5–5%**

coupling needed to stop star formation

# 3 types of winds, categorized by speed



**UFO** Ultra-Fast Outflow

$v > 10,000 \text{ km/s}$  (up to  $0.33c$ )

**VFO** Very Fast Outflow

1,000 – 10,000 km/s

**WA** Warm Absorber

100 – 1,000 km/s

\*  $c$ : speed of the light

# NGC 4151 - “Eye of the Sauron” - our best laboratory

Distance

**60 million  
light-years**

Black hole mass

**30 million  
of the Sun**

## Past X-ray wind detections

- ASCA 1990s *First hints of Fe absorption*
- Chandra 2000s *Winds detected, but blended*
- XMM-Newton 2000s *Fast outflow candidates*
- XRISM 2023– *Each layer resolved clearly ✓*  
(X-ray Imaging and Spectroscopy Mission)

# X-rays sees winds closest to the black hole

## XRISM sees wind layers the clearest

(X-ray Imaging and Spectroscopy Mission)

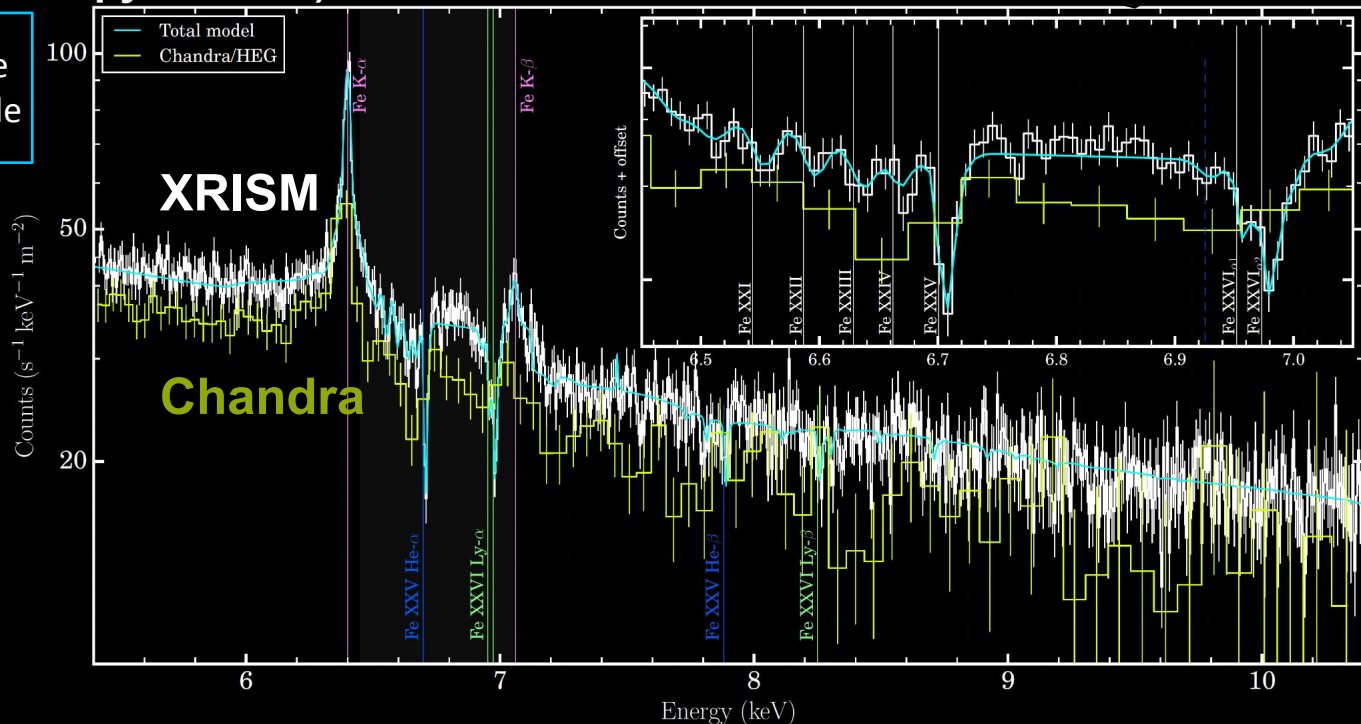


Fe XXV & XXVI at 6–9 keV trace hot, fast gas near the black hole

Blueshifted lines directly encode wind velocity

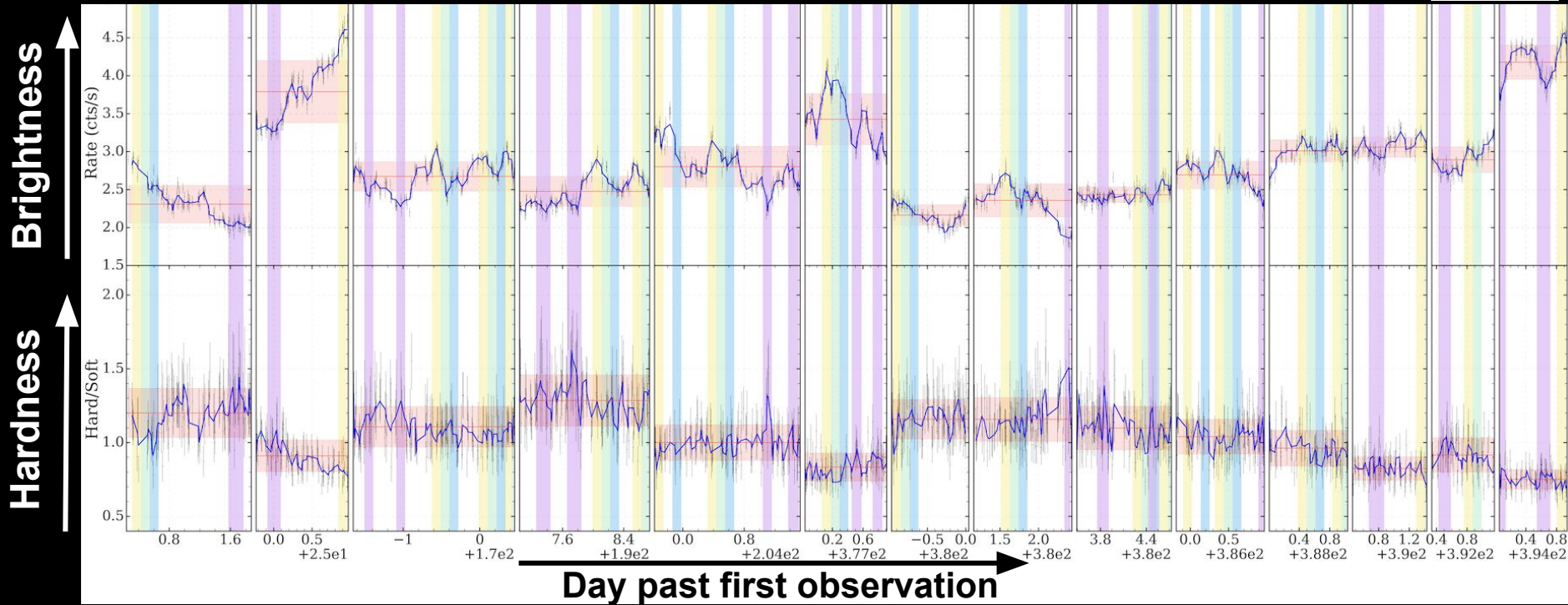
Line strength gives energetics of the outflow

Previous telescopes lacked resolution to separate layers



# Fast winds fire ~10,000 seconds after a bright flare

- Flare
- Postflare
- After
- Hard-Dip



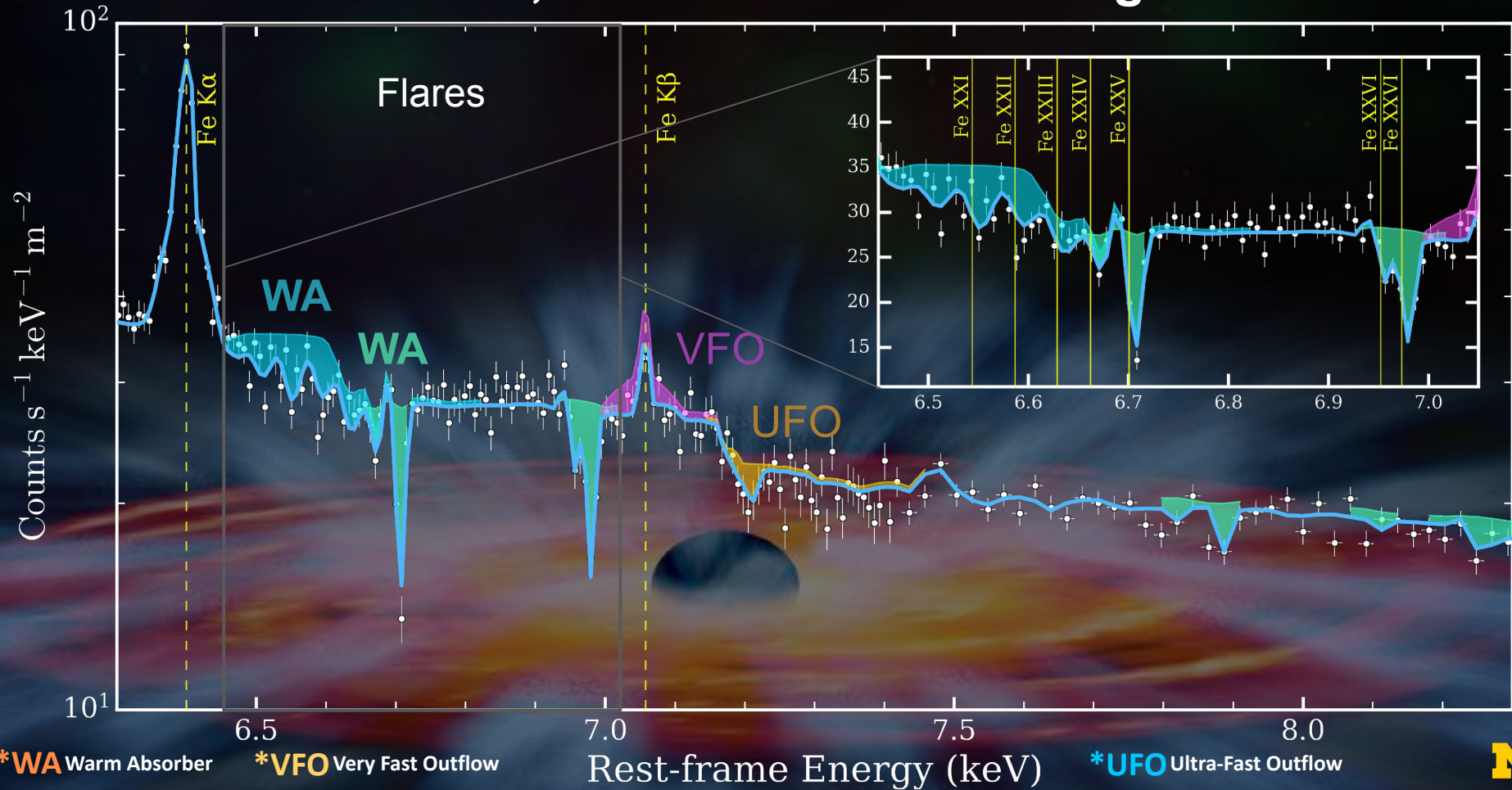
**Flare**  
No fast winds

**Post-Flare**  
UFOs peak (~10 ks later)

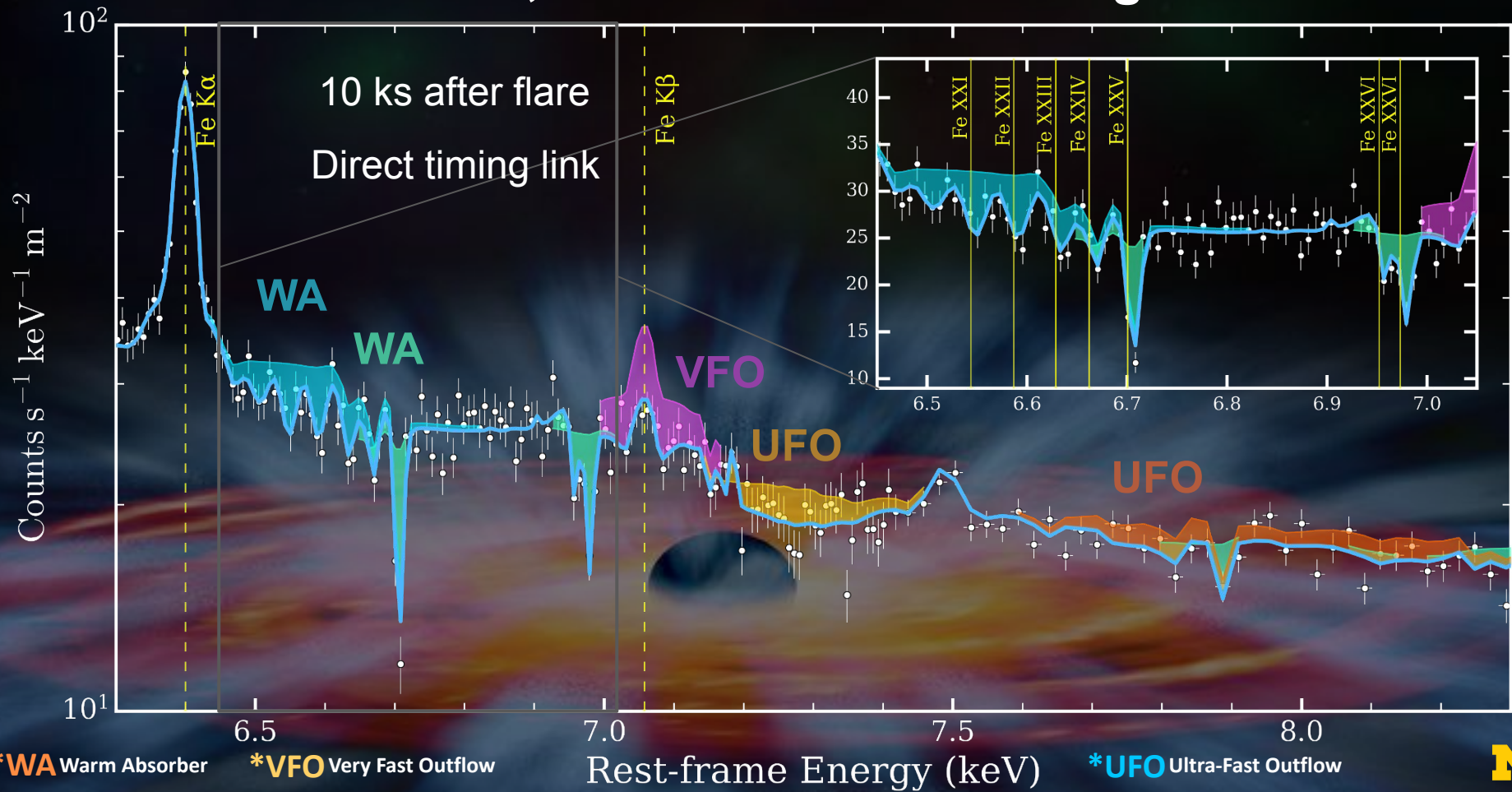
\*Hardness = color



# Fast winds fire ~10,000 seconds after a bright flare

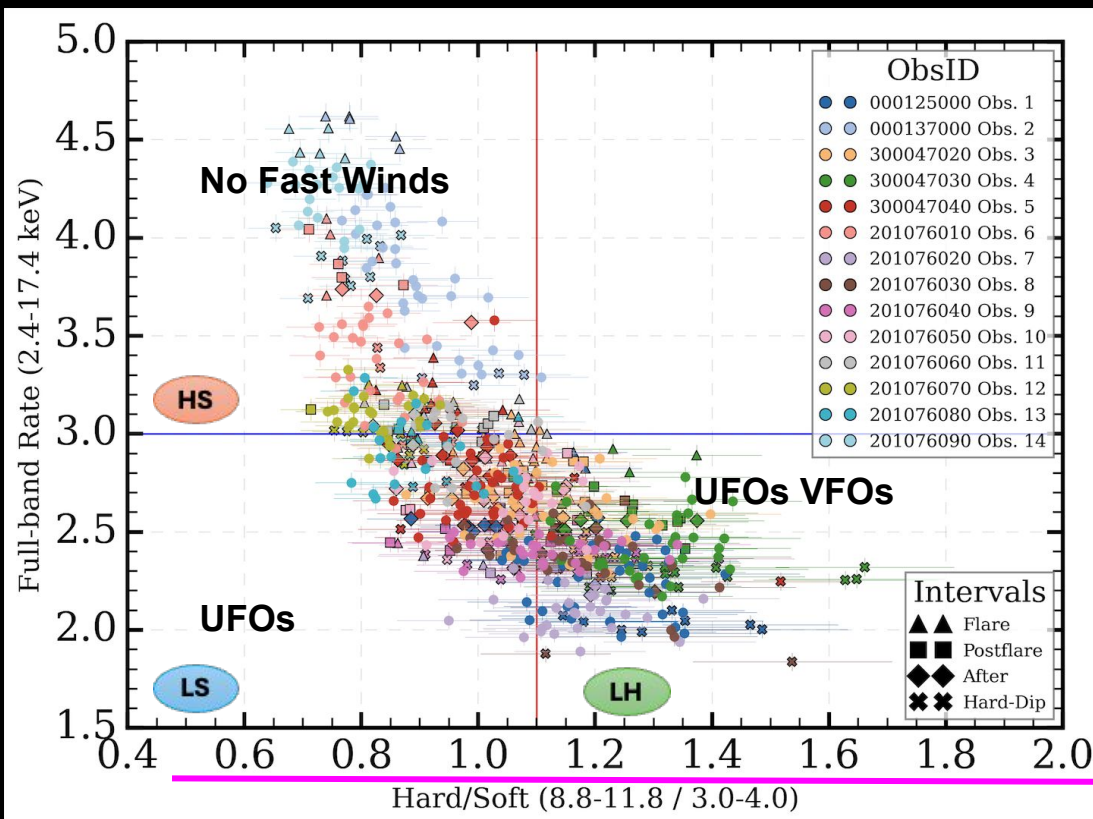


# Fast winds fire ~10,000 seconds after a bright flare



# Fast winds active at low brightness

Brightness



Hardness



**Flare**  
No fast winds



**Post-Flare**  
UFOs peak (~10 ks later)

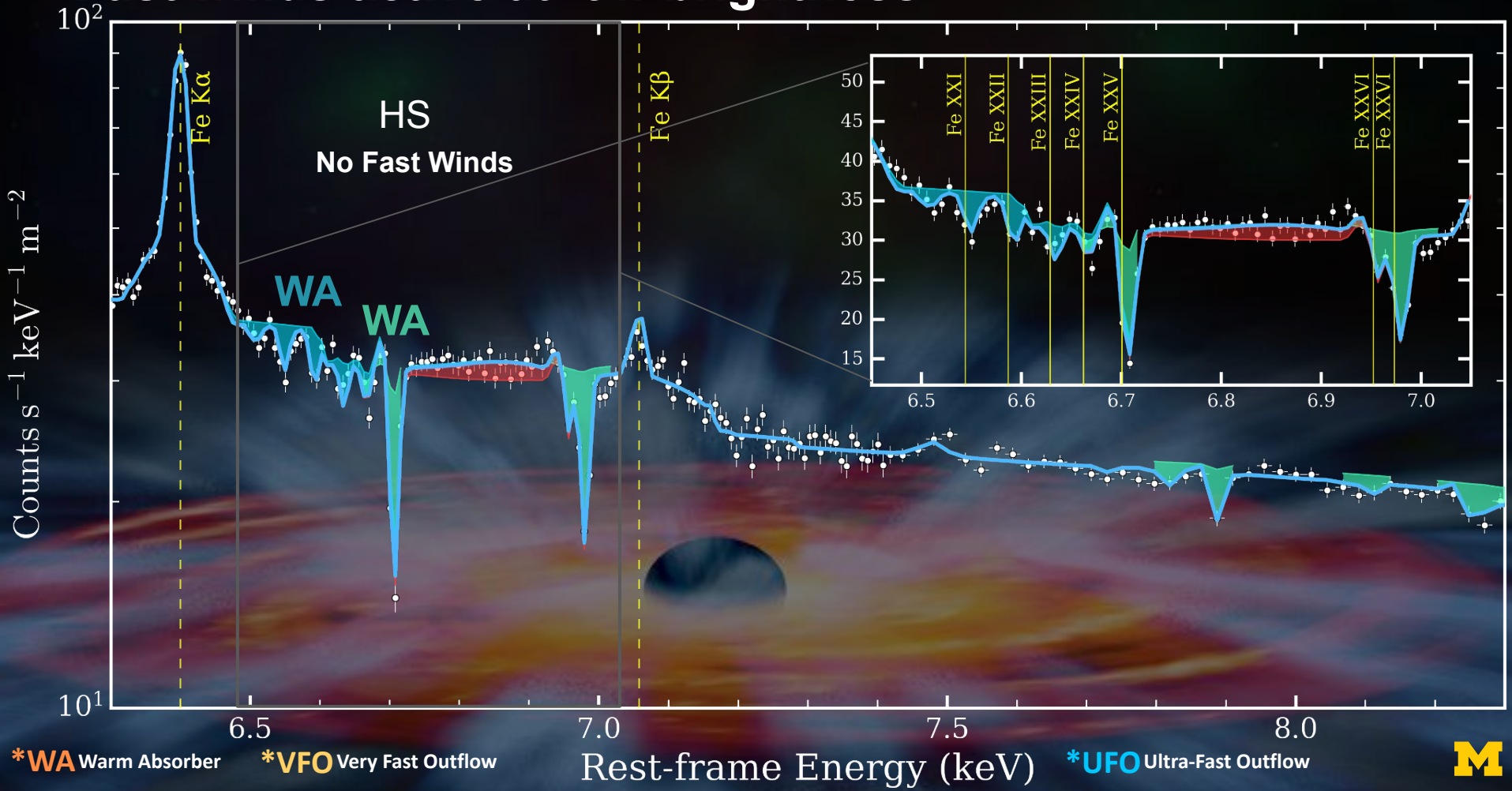


**High-Soft**  
Fast winds absent

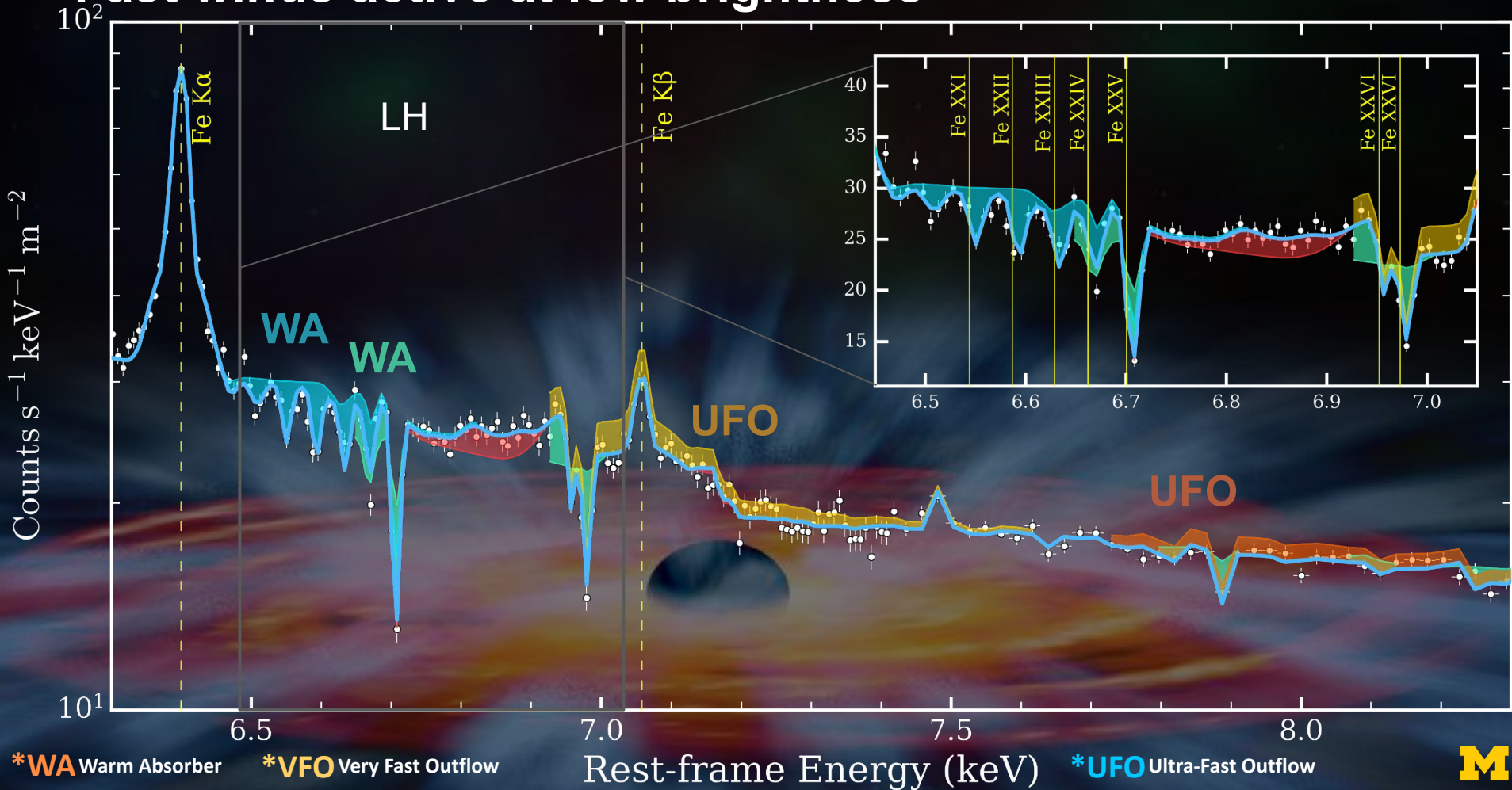


**Low Brightness**  
VFO+UFO active

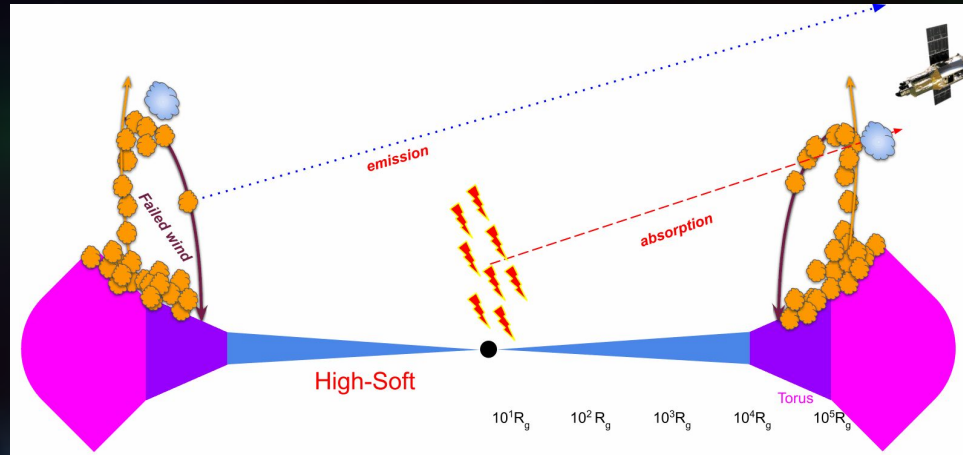
# Fast winds active at low brightness



# Fast winds active at low brightness



# Summary



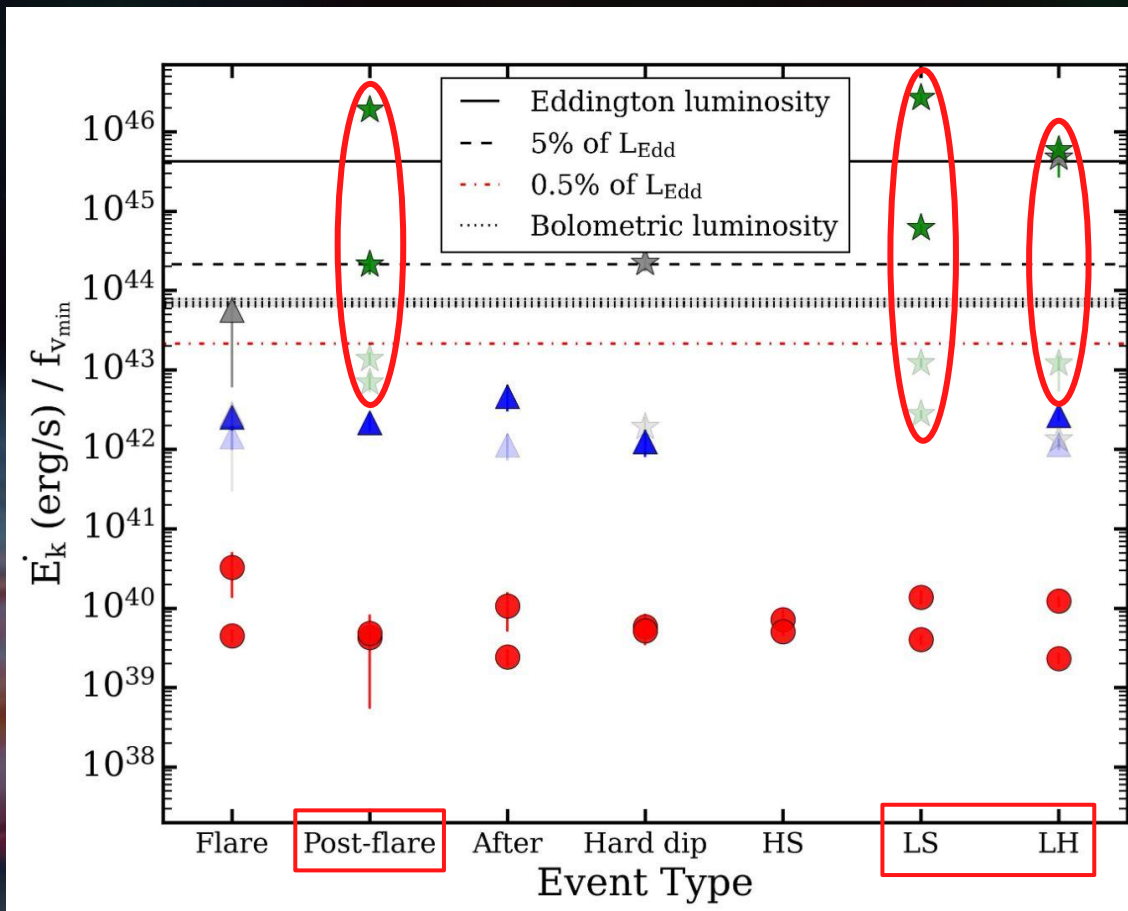
- WAs are stable and circulating
- Fast outflows are strongest 10ks after flare - first direct timing link
- UFOs are strongest when the source is at faint region
- Episodic UFO feedback can quench star formation in NGC 4151
- Magnetic-centrifugal force launches the fast outflows

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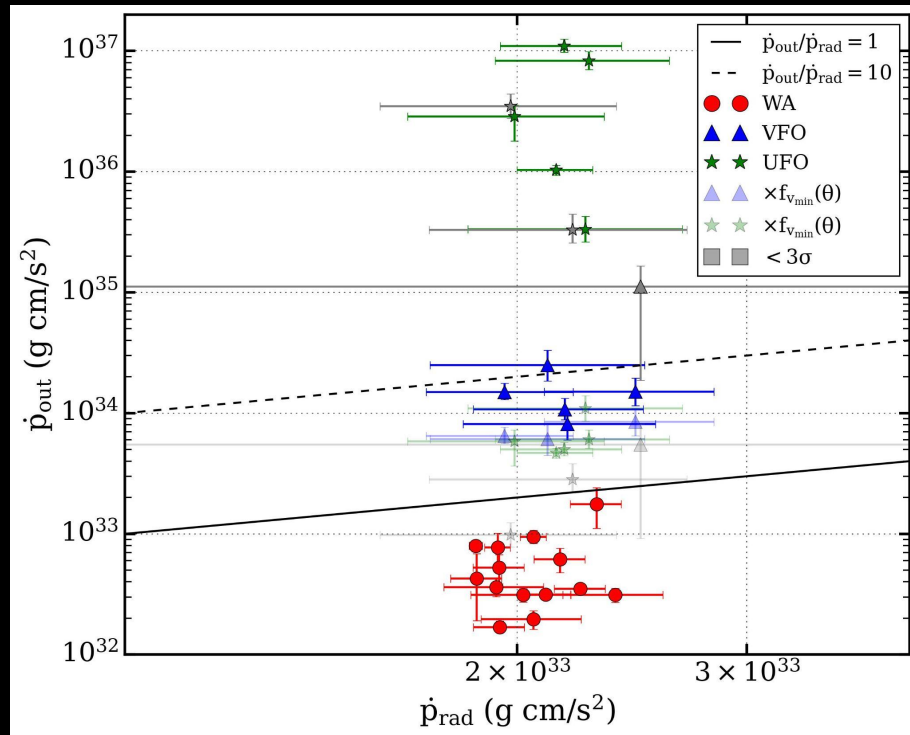
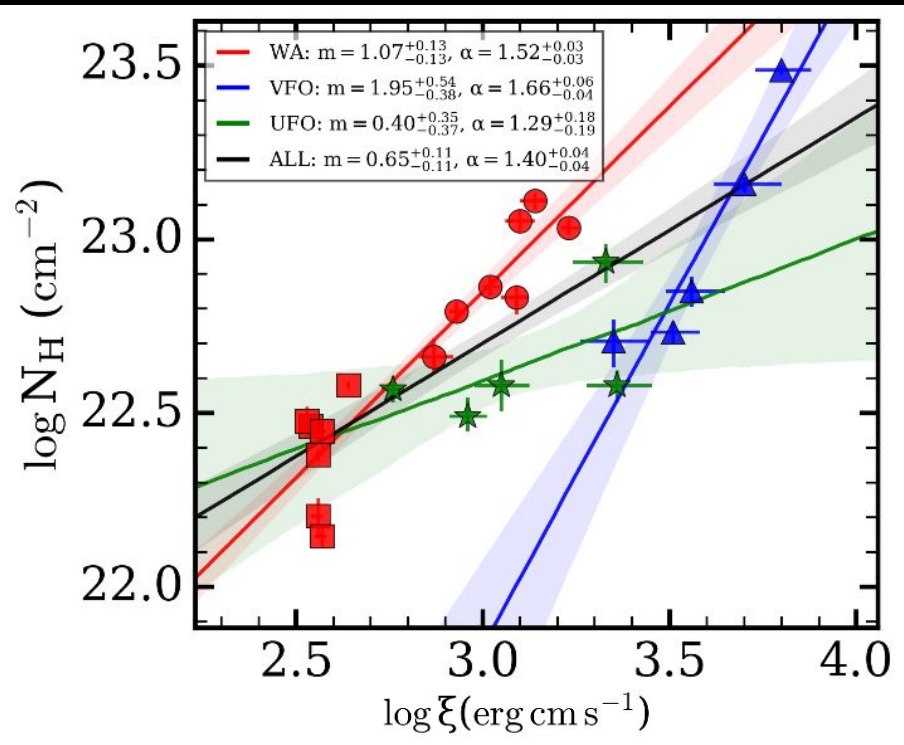
Questions?

# Bonus Slides

# Energetics - UFO feedback is powerful and episodic



# Magnetic launch with helps of radiative pressure



# Radius

