Capturing a pulsar "powering up"

Adelle Goodwin
Monash University

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In collaboration with David Russell, Duncan Galloway, Maria Cristina Baglio, Aastha Parikh, David Buckley, Jeroen Homan, Jean in 't Zand + collaborators

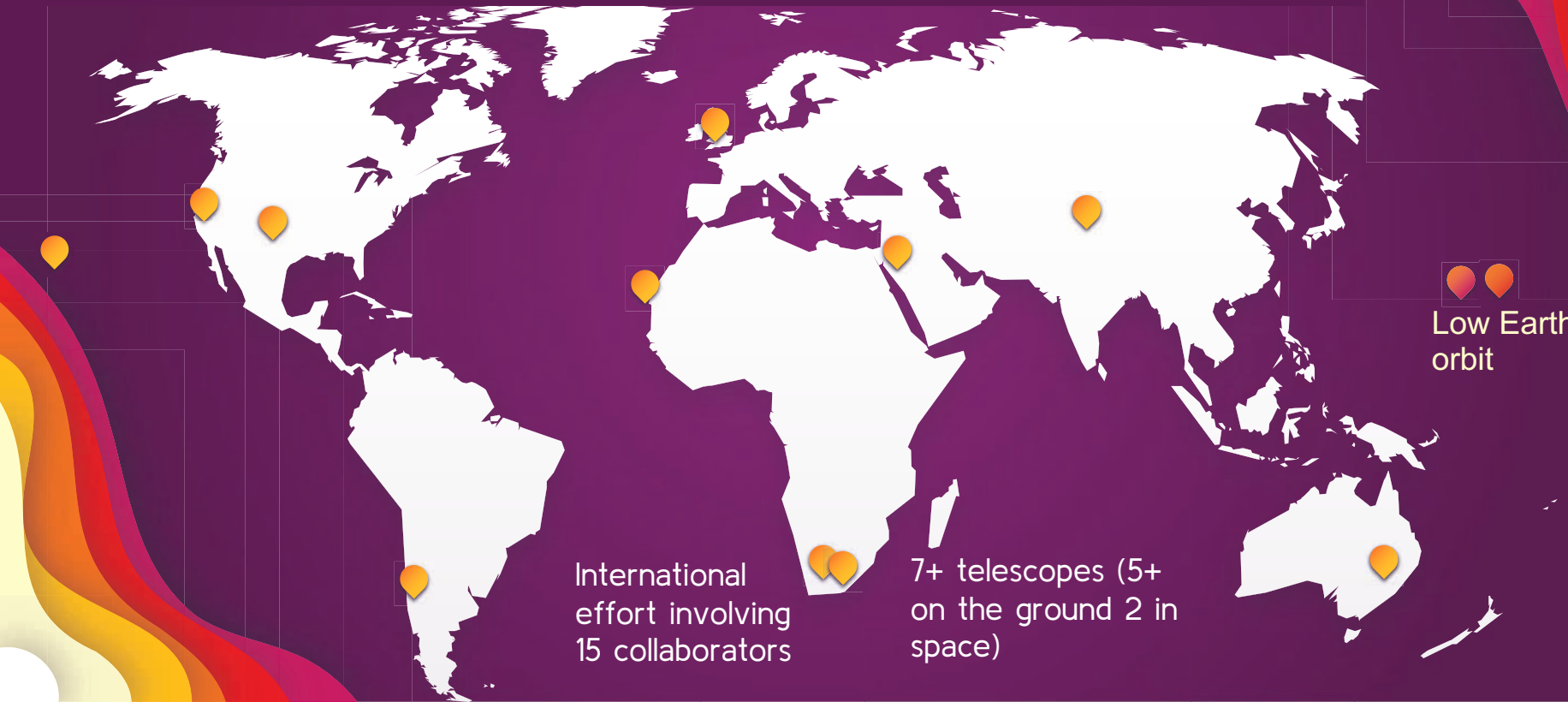
MONASH University

JINA-CEE

Contact info:
adelle.goodwin@monash.edu
Twitter: @astro_del
Whatsapp/mobile: +61448561646

We captured an accreting pulsar “powering up” in the most detail to date

For the first time we observed the full 12-day process of material spiraling into a distant neutron star, triggering an X-ray outburst thousands of times brighter than our Sun



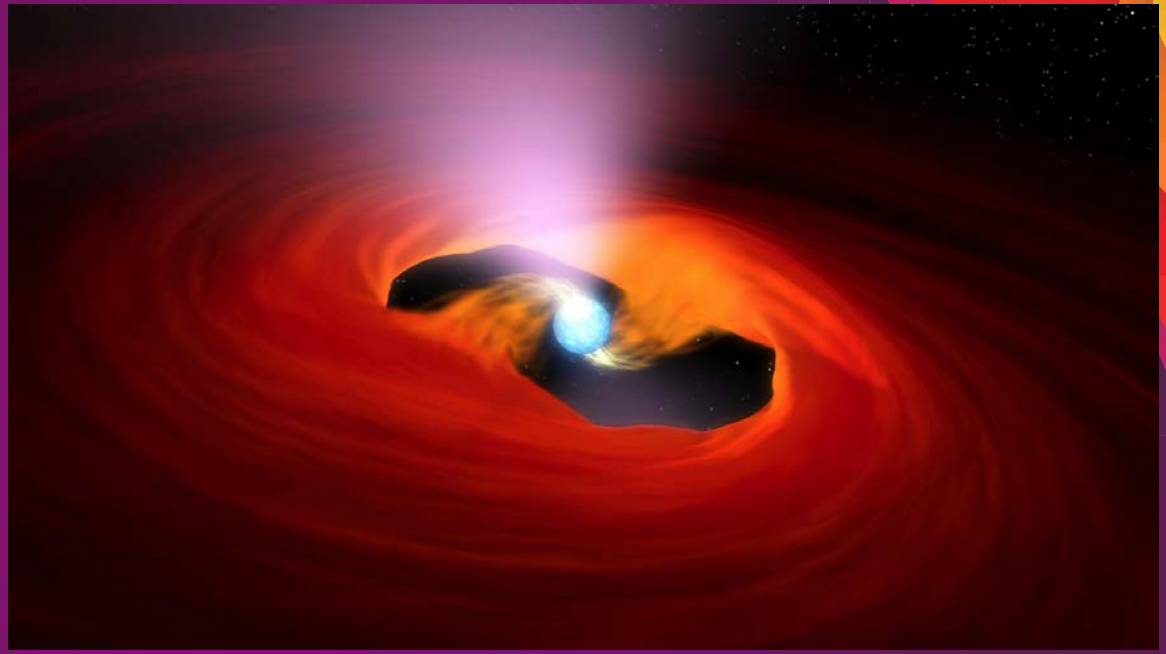
Accreting Pulsar

Neutron star orbiting with a “normal” star

Matter flows from the companion to the neutron star forming a disk

They go through periodic “outbursts” where the material from the disk falls onto the neutron star

Outbursts release extraordinary amounts of energy in a few weeks, then the system goes quiet again



Artist’s impression: NASA

What were we looking at?

SAX J1808.4-3658

- Spins 400 times per second
- Located 11,000 light years away in the Sagittarius constellation
- Close 2 hour binary orbit
- Goes into outburst every 2-4 years
- First accretion-powered millisecond pulsar ever discovered in 1996


LCO


LCO


LCO


LCO


Swift


NICER, aboard the ISS


LCO


SALT

What did we see?

Optical activity July 25 2019

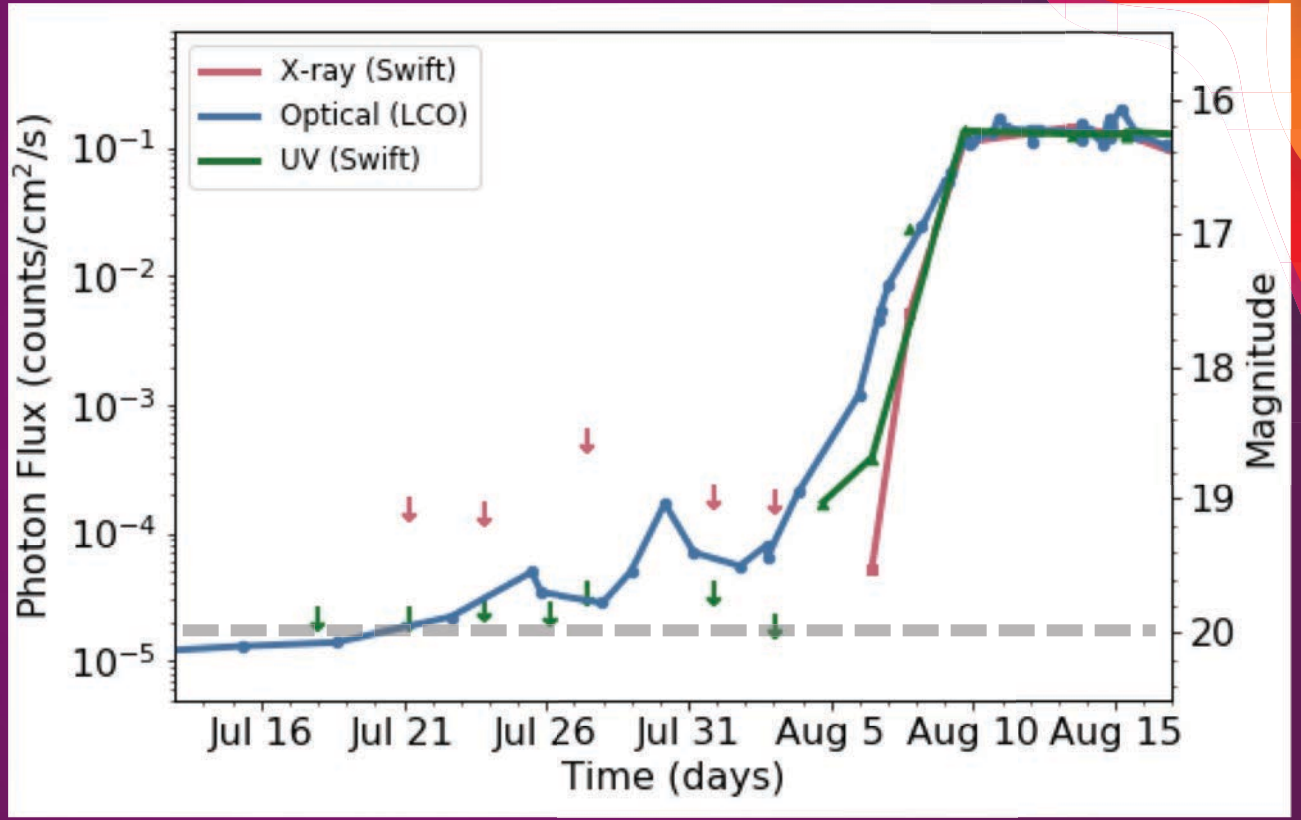
Optical rise August 1 2019

UV rise August 4 2019

X-ray rise August 6 2019

2 day delay between optical -> UV -> X-ray

12 day delay between optical to X-ray




That's a
12 day delay
between the optical and X-ray emission

Why did it take so long (12 days)?

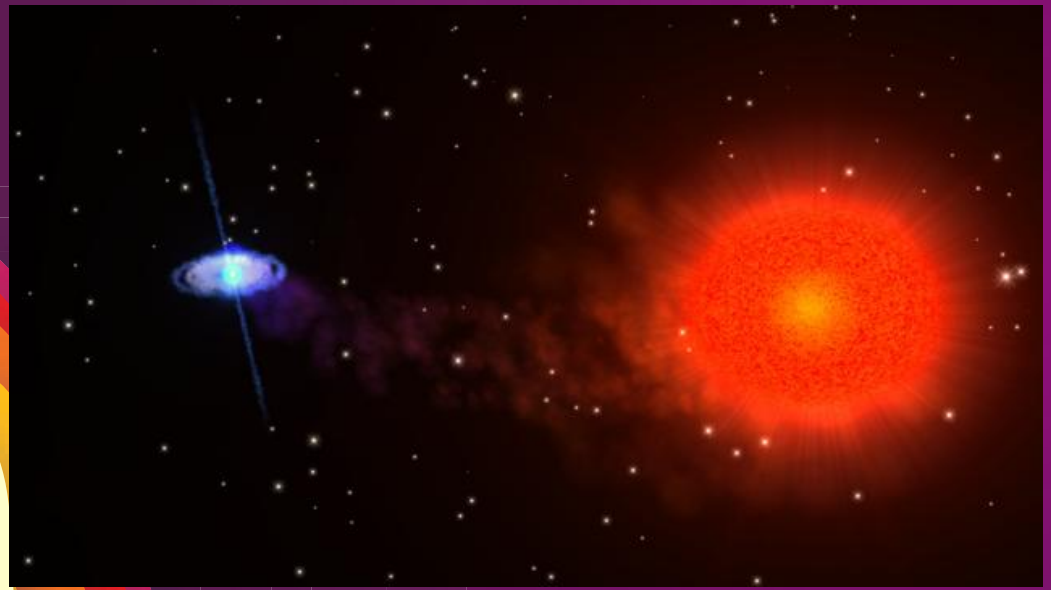


Image: NASA

Lots of helium in this disk (50%)

→ We think this delays the heating of the disk because helium requires a hotter temperature to “burn” (ionize)

This is the first observation of such a long delay

Summary

First ever comprehensive observations of a low mass X-ray binary rise to outburst

These observations will be useful in testing theory and understanding the missing physics. Previous obs infer delay from less sensitive all sky monitors.

Longest delay between optical to X-ray rise

Could this be because the helium in the disk needs to be ionized too, and requires a hotter temperature?

Outburst is probably caused by hydrogen ionisation (confirms theory)

We measured the temperature of the disk during the rise to outburst to confirm this

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