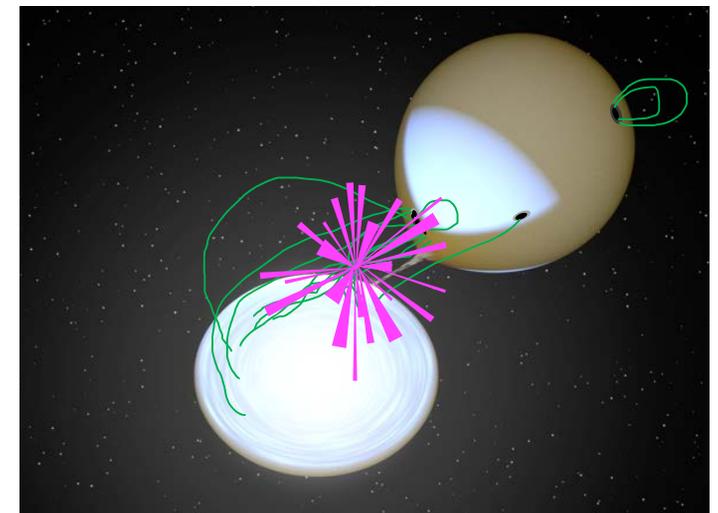
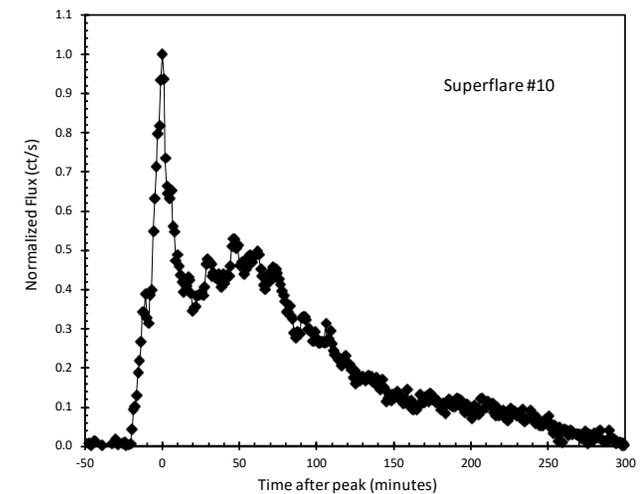


# DISCOVERY OF EXTREME SUPERFLARES ON THE RECURRENT NOVA V2487 OPH

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1. Louisiana State University, 2. College of Charleston

- ★ V2487 Oph is a recurrent nova
  - Nova eruptions in the years 1900 and 1998
- ★ V2487 Oph has extreme Superflares
  - Once per day, lasting for an hour or so
  - 20 Mega-Carringtons per flare
  - >100,000X energy budget of any known Superflare star
- ★ Superflares from magnetic-reconnection
  - Same mechanism as for solar flares
- ★ Hard challenge to explain
  - How to get such huge magnetic fields?
  - Why does V2487 Oph have such large Superflares?
- ★ Superflares would kill all life on surrounding exoplanets



# NOVA V2487 OPH (1998) IS A RECURRENT NOVA; THE RAREST OF ALL TYPES OF VARIABLE STARS

## Nova Oph 1998

## 1900 Eruption

## The System

Period =  $1.24 \pm 0.02$  days

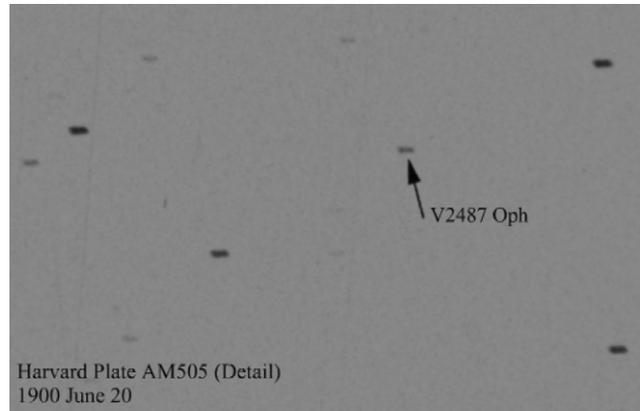
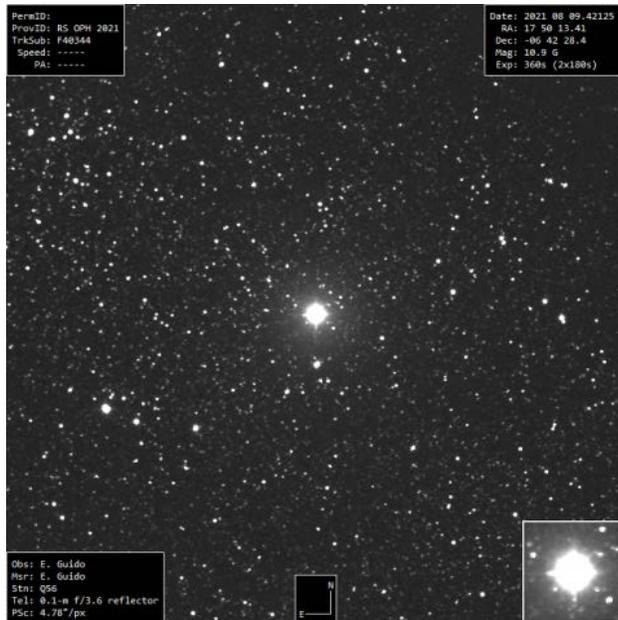
$M_{\text{wd}} = 1.35 \pm 0.05 M_{\odot}$

$M \sim 1 \times 10^{-7} M_{\odot} / \text{year}$

→ Recurrence Time  $\sim 18$  yrs

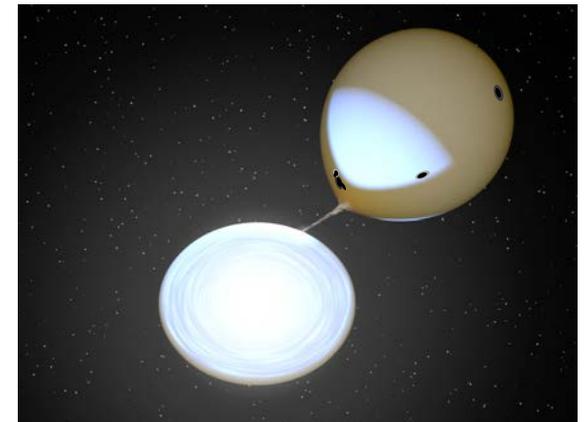
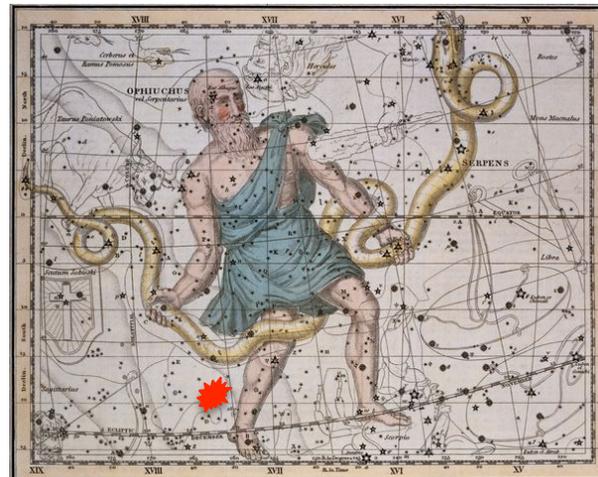
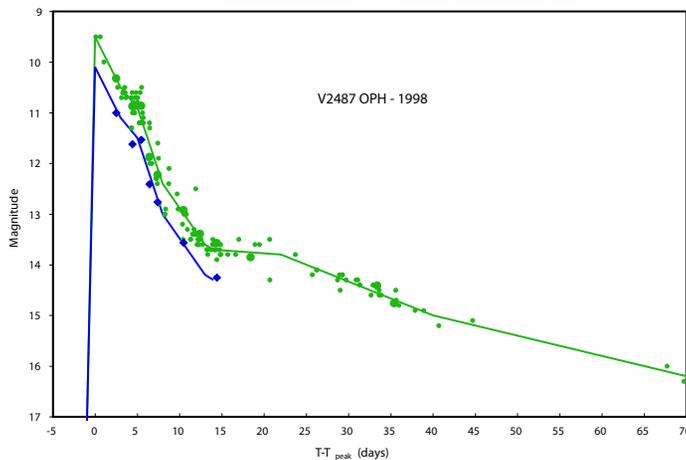
$T_{\text{companion}} = 6000^{\circ} \pm 1000^{\circ}$

Distance  $\sim 26,000$  light-years

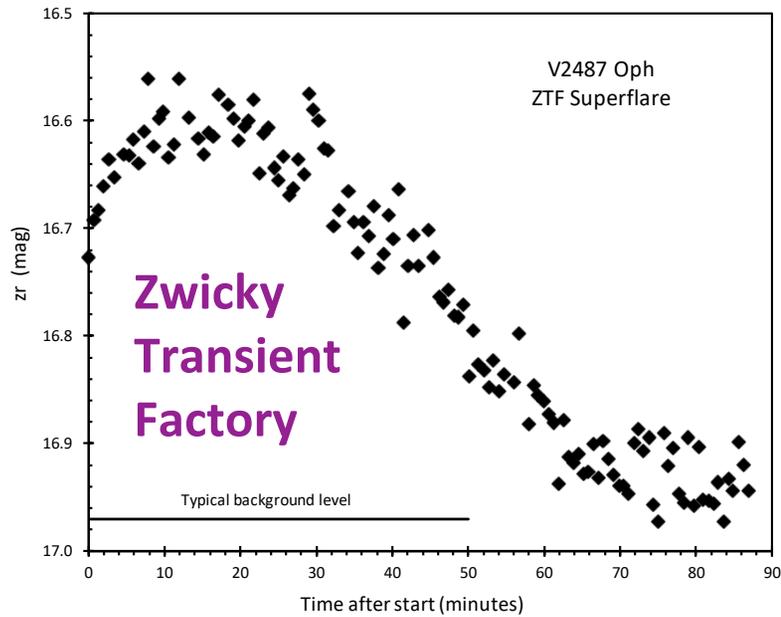
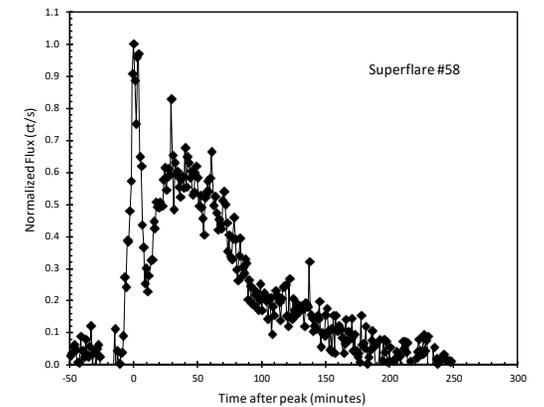
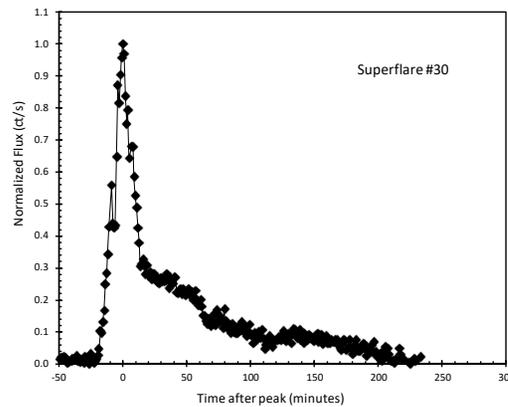
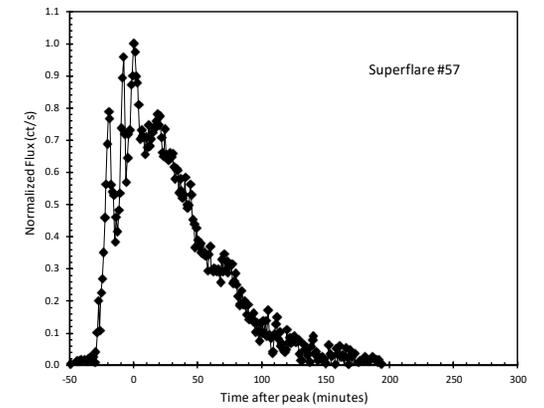
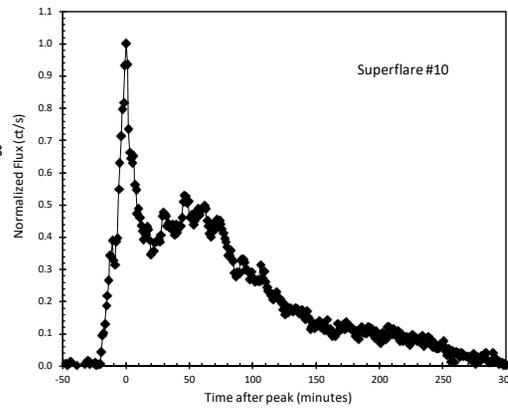
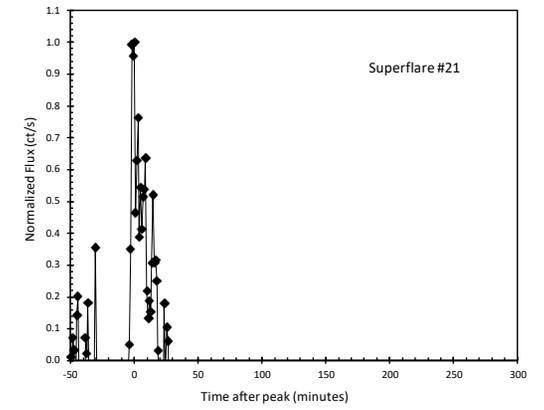
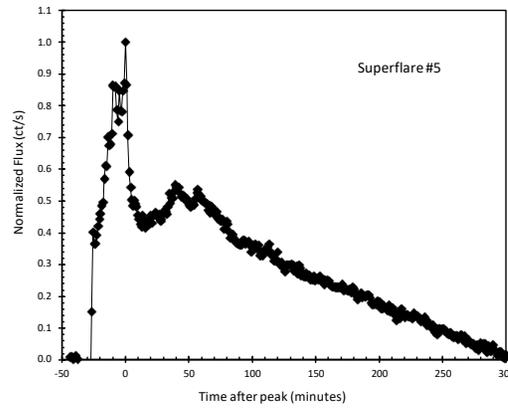
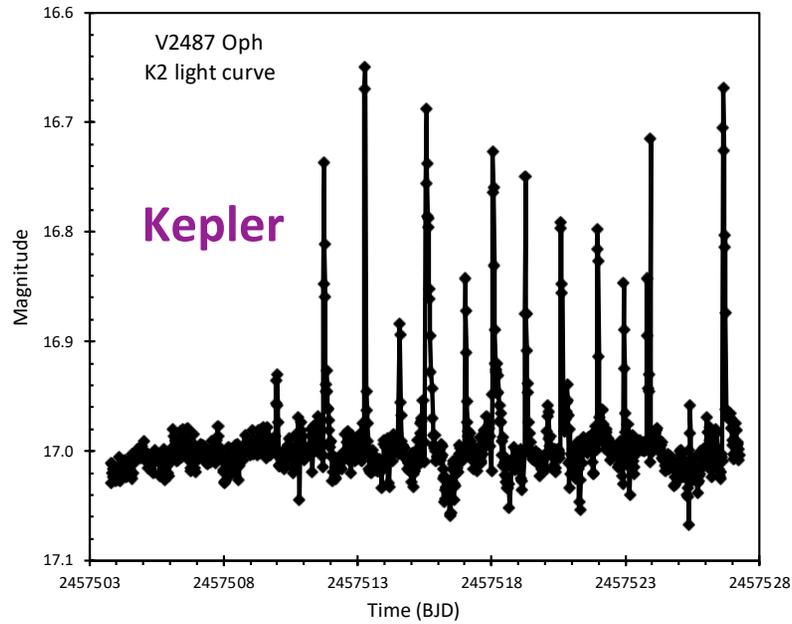


Pagnotta et al. 2009, AJ, 138, 1230

So V2487 Oph is one of just ten known recurrent novae in our Milky Way



# V2487 OPH HAS SUPERFLARES



# SUPERFLARES!

Discovered & named in 1989

Schaefer 1989, ApJ, 337, 927

Wonderful Kepler light curves in 2012

Maehara et al. 2012, Nature, 485, 478

Huge flares on normal stars

- Energy > 100 Carringtons
- Duration ~ hours
- Very bright from X-rays to radio

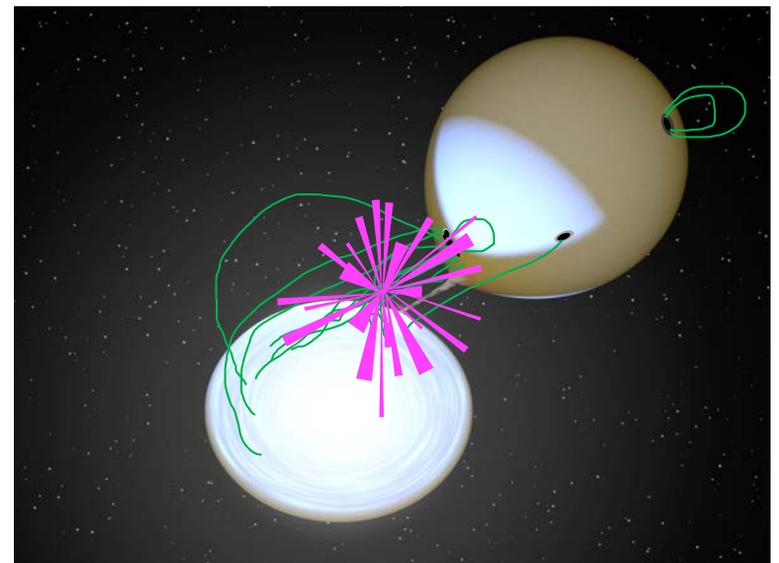
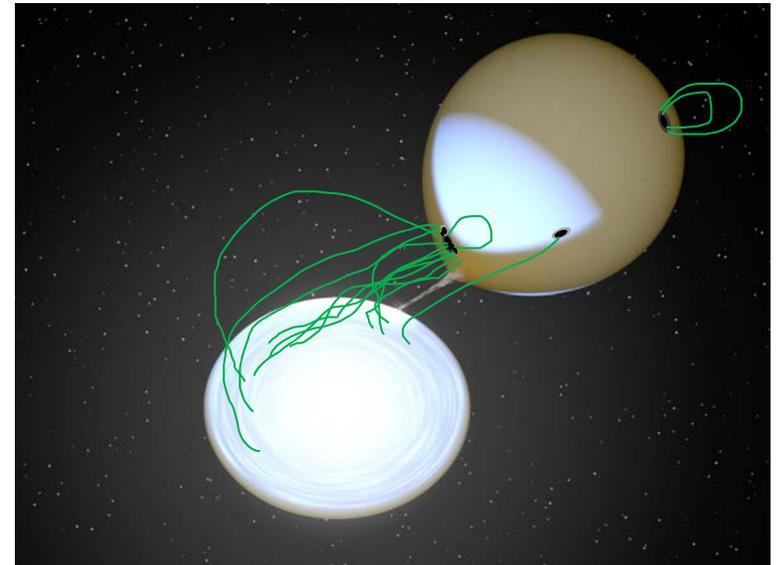
Seen on *all* types of normal stars

- Sun-like stars (including closest solar twins)
- All along main-sequence (B-M and L)
- White dwarfs, sub-giants, giants, supergiants
- Mira stars, RS CVn stars...

All caused by magnetic-reconnection



V2487 Oph scenario:



# CONSEQUENCES OF SUPERFLARES

- ★ DIRECT RADIATION WILL KILL ALL UNPROTECTED LIFE
- ★ SUPERFLARES WILL DESTROY OZONE LAYER,  
LETTING THE STAR'S ULTRAVIOLET LIGHT STERILIZE THE PLANET SURFACE
- ★ WRECK ALL SATELLITES AND ELECTRONIC TECHNOLOGY
- ★ SUPERFLARE RADIATION WILL STRIP ALL ATMOSPHERE FROM PLANETS



# V2487 OPH: MOST EXTREME SUPERFLARE STAR

	<Time Interval>	Energy per flare	Energy per year
V2487 Oph	1.1 day	20 Mega-Carringtons	1 Giga-Carrington
Superflare Stars	10 days - 1 century	100 – 10 <sup>6</sup> Carringtons	<10000 Carringtons
Flare Stars	~1 month	~10 Carringtons	~1 Carrington
Carrington Event	~5 centuries	1 Carrington	0.01 Carringtons
Solar Flares	~ 1 year	0.01 – 1 Carrington	~0.1 Carringtons

1 Carrington  $\sim 10^{32}$  erg

V2487 Oph: most frequent Superflare star

V2487 Oph: >10X more energy-per-flare than any other

V2487 Oph: >100,000X larger yearly energy budget

# V2487 OPH SUPERFLARES ARE...

## ★ ... STARTLING

- Nothing like this has ever been seen or imagined
- All other known Superflare stars are 'normal'
- Superflares not seen on any other nova, recurrent nova, ...

## ★ ... BY-FAR THE MOST POWERFUL KNOWN

- >10X more powerful than any known Superflare
- >10X more frequent than any other known Superflare star
- >100,000X more energy per year than any known Superflare star

## ★ ... NOW A HARD CHALLENGE FOR THEORISTS

- How is it possible to regenerate the huge needed magnetic fields once a day?
- What is the configuration of the magnetic field lines?
- Why do no other novas or recurrent novas have huge Superflares?

## ★ ... BAD FOR LIFE ON EXOPLANETS

