

## ASTR 5590 - Millisecond pulsars, magnetars, and AXPs

★ What happens when NSs have accreted matter for a long time?

★  $\dot{p} - \dot{p}$  <sup>disk</sup>  
- disk accretes matter in 1 direction, adds angular momentum

1980s  
discarded

↳ NS "spins up", curvature radiates again a viable mechanism to produce particle cascades, reborn a pulsar

↳ need a weak B to add ang. mom., otherwise gets channeled to the pole & surface

- eventually, donor star explodes or becomes a WD: most ms pulsars are in binaries

↳ if SN is asymmetric, can disrupt system, leaving it isolated

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Also pulsars can be isolated, have

$\uparrow P + \dot{P}$ , emit in X,  $\gamma$ -rays

SGRs: soft  $\gamma$ -ray repeaters

AXPs: anomalous X-ray pulsars

$$2 < P \leq 15s$$

→ inferred B fields very strong

→ why the confusing names?

- obs. based, seen by RXTE/Swift

↳ 1990s + 2000s (1st ones in 80s)

Total class known as magnetars

-  $\frac{dE}{dt}$  not from rot. KE (too small)

- B field itself (+ its decay?)

powering radiation → gone after 10k yr

- just born that way?

est. take 1/10 NS are born as magnetars

↳ could result from merger of 2 NSs

↳ generally experience outbursts, then fade in brightness

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Black Widow Pulsar → ms pulsars

Redback Pulsar → in binaries abating their

Rotating Radio Transient → companion

↳ possible class of magnetar

CCOs  $\rightarrow$  isolated sources in centers  
of SNRs, no PWN, dominated  
by hot thermal emission ( $\sim 0.8$  keV)  
 $\rightarrow$  hot b/c young: cools rapidly  
to  $\sim 10^6$  K (0.1 keV) after  
 $\sim 1000 - 10,000$  yr

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NS Pop. in the Galaxy

May Slide

Found where one would expect  
given how they're formed

- ★ Why are SNR pulsars there?
  - ★ Why are ms pulsars there?
  - ★ Why are radio pulsars there?
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X-ray shy @  $\uparrow$  E (next slide)

- some are pulsars / PWN
- some are SNR (young ones)
- most are X-ray binaries
  - most have accreting NS
  - rest (likely) have accreting
  - "

RSITS