

# **Isolated Neutron Stars: From the Surface to the Interiors**

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“It’s kind of interesting. I don’t know why.”

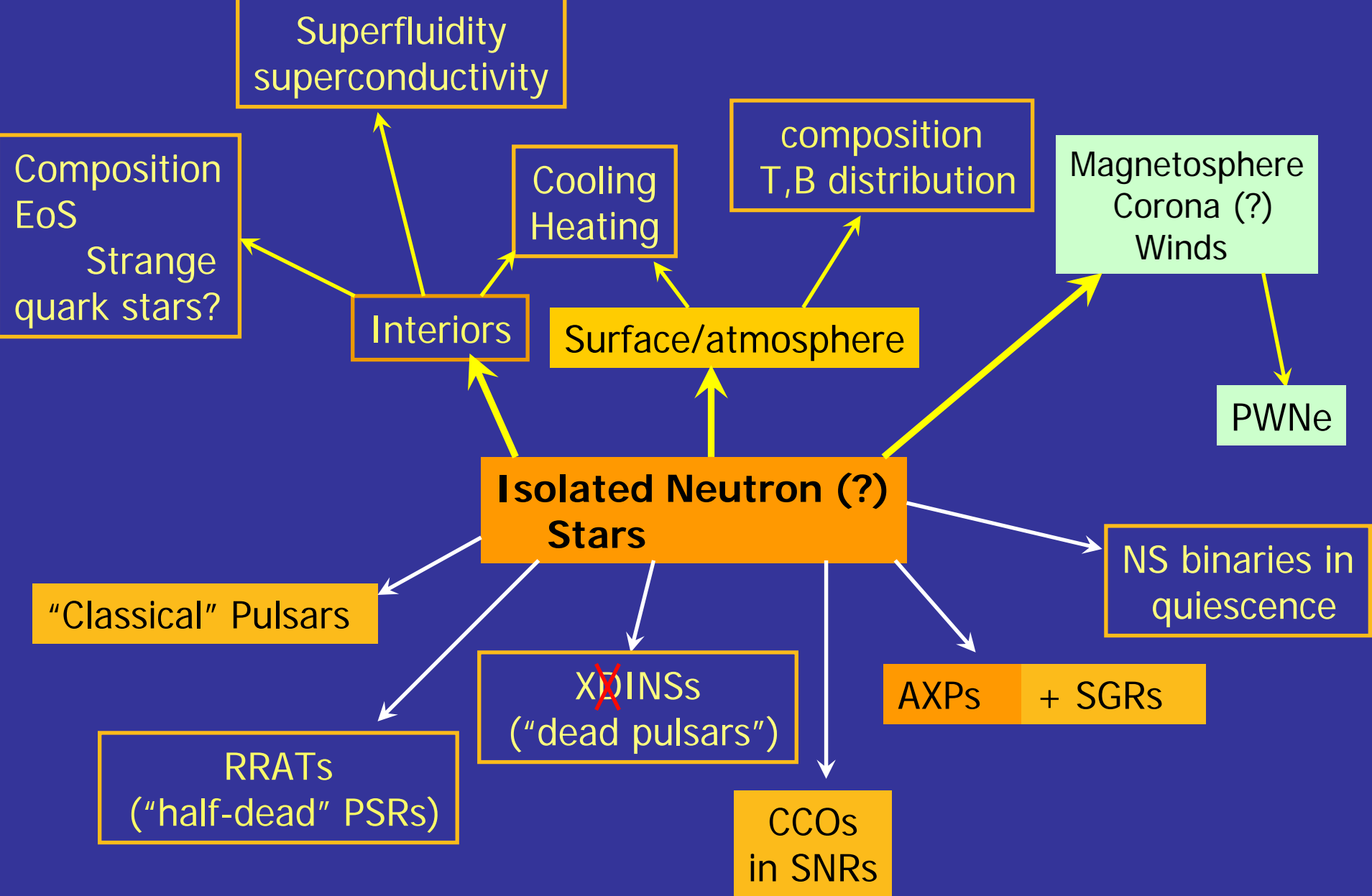
(Eric Gotthelf)

“I am not old enough to insult other people”

(Tracey DeLaney)

“I solved all these problems  
when I was a postdoc.”

(Dong Lai)



# Classical Pulsars: Highlights

- Increased sample of pulsars detected with Chandra and XMM, including many new thermal soft-X-ray emitters [Becker, Zavlin, McGowan, Gonzalez, ...]
- New hard X-ray (Integral, RXTE) data: Hard spectral tails with strong pulsations [Kuiper, Hermsen]
- Thermal FUV emission from 3 PSRs [Kargaltsev]
- Hints of hot polar caps from many PSRs, often with surprisingly small sizes [Zavlin, Gonzalez, Gil]
- New NS atmosphere/surface models [Pons, Mori, Ho, Lai]
- Surface temperature is nonuniform, and magnetic field possibly nondipolar, with a toroidal component [Pons, Zane, Ruderman, Page]
- RRATs; transition to magnetars? [Lyne, Gaensler]

# Classical Pulsars: Open issues

- Connection between optical, X-ray and gamma-ray components of nonthermal radiation (models needed)
- Do we really see hot polar caps? If yes, why are they so small? Heated from outside or from inside?
- Properties of NS surface: Composition: H, He, O,... Fe? Solid or gaseous? Distribution of T and B?
- Reliable models of surface/atmosphere thermal emission (can we use the “temperatures” to infer the properties of NS interiors?) Isn’t the cooling theory “too advanced”?
- Why no spectral lines (contrary to XINSs) ???
- Is the observed thermal emission reprocessed in the pulsar magnetosphere?
- Do NSs just cool or there is appreciable heating?

# AXPs/SGRs: Highlights

- Hard X-ray tails (Integral, RXTE) [Mereghetti, den Hartog, Gotz]
- Magnetar corona model [Beloborodov]
- Reprocessing of surface emission in the corona or/and magnetosphere [Fernandez, Rea, Baring]
- Spectral line(s) ? [Ibrahim]
- The giant flare of SGR 1806-20 [Israel, Gotz], including extended radio emission [Gelfand]
- QPOs in giant flare aftermath [Watts, Israel ]
- Transient AXPs [Gotthelf, Tam]
- Magnetar progenitors: Massive, strongly magnetized, not exceptionally fast rotators [Gaensler, Vink]
- Magnetars can form from some classical pulsars? [Lyne]
- Gravitational waves from newborn magnetars [Stella, Dall'Osso]

# AXPs/SGRs: Open issues

- Quiescent emission at  $E < 10$  keV (“thermal” + “soft PL”): reprocessing in the corona?
- Origin of NIR/optical emission
- Are quiescent magnetars radio sources?
- Are there fall-back disks after all?
- TAXPs vs AXPs: Why so different behavior?
- AXP-SGR connection: What is the intrinsic difference?
- Creation vs. evolution: Evolved from (some) pulsars?

# CCOs in SNRs: Highlights

- Binary nature of 1E1207-5209? [Woods]
- New interpretations of lines in 1E1207-5209: Oxygen? [Mori], exotic “magnetic molecules”? [Turbiner]
- Puzzling CCO in RCW 103: LMXB? TAXP? [De Luca]



# CCOs in SNRs: Open issues

- Is it a distinct population or just a random collection of weird objects?
- Why so hot and small (e.g., Cas A CCO)?  
Strange quark stars?
- CCO-magnetar connection?
- Nature of spectral lines in 1E1207-5209. Why no lines in other CCOs?

I would appreciate sending me your suggestions on Open Issues to include them in the Conference Proceedings.

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# Most inspiring discovery:

There are wonderful creatures in the land of NSs  
whose “age decreases with time  
and magnetic field keeps growing.”

(Andrew Lyne)