

IMPORTANT QUESTIONS IN THE FIELD OF PULSAR WIND NEBULAE

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Abstract

Sometimes the most important step toward making scientific progress is figuring out the correct question to ask. Discussion leaders at the X-Ray and Radio Connections Meeting were asked to create a list of important questions in each field which, if we worked on them and met again in five years, we would have made progress on the issues presented at the meeting. Here are the important questions for pulsar wind nebulae.

Pulsar wind nebulae in 2004

With the new century, we have entered a new era in the study of pulsar wind nebulae (PWN). Due to the new high-resolution missions, we are finding that the nebulae are highly structured x-ray objects. We have also found that a large fraction of x-ray and radio emitting PWN have a cometary morphology. Whether these new observations will shed light on long-standing puzzles in PWN research or simply add to the complexity of the problems has yet to be seen.

Old questions, where there is some progress, but much more needed

- 1) How and where does the ultra-relativistic pulsar wind form, and how magnetized is it?
- 2) How does an efficiently emitting power-law spectrum of particles result from this ultra-relativistic wind after the termination shock (i.e., the sigma problem)?
- 3) Are the radio emitting particles accelerated at the same site?
- 4) Does the flat radio spectrum suggest the low-energy particles are not shock accelerated? If so, what is the acceleration mechanism?
- 5) Is there a minimum spin-down energy needed to create a bright PWN?

New questions due to recent X-ray imaging advances

- 1) Why are jet-like outflows ubiquitous in PWN?
- 2) What determines the ratio of polar to equatorial outflow?
- 3) Are all polar axes aligned with the pulsar spatial velocity? And how well?
- 4) What causes the spatial variability seen in the X-ray and optical nebulae?
- 5) For rapidly-moving PWN (rPWN), how does the ram-pressure interact with a relativistic wind to form the different down-stream morphology? And does this depend on the intrinsic pulsar geometry?
- 6) Why do rPWN seem to close in back?
- 7) Are rPWN γ -ray emitters?