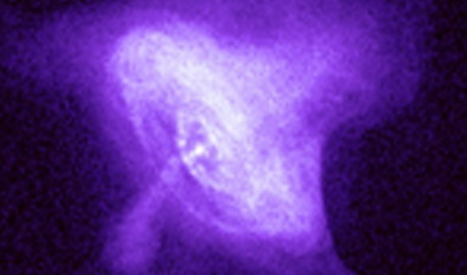
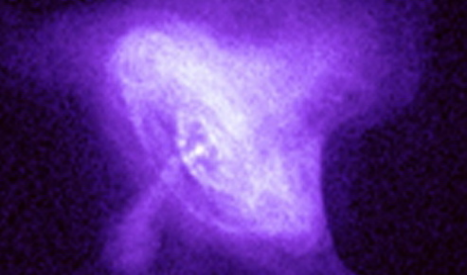


A Small Satellite Scientist Looks at Nanosat Capabilities

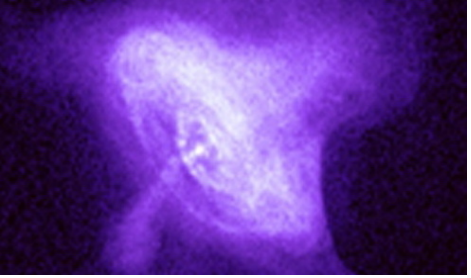
April 10, 2008

John Doty, PhD, Noqsi Aerospace, ltd



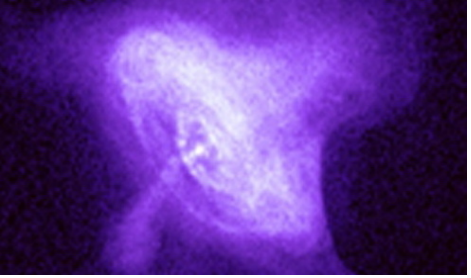
Galileo and Scaling

- Square-cube law (1683)
  - weight □ l^3
  - strength □ l^2
- Many other scalings favor small l
  - Thermal distortion
  - Speed and power of circuits
  - Telescope area/mass
  - Telescope area/$



Scaling Drivers

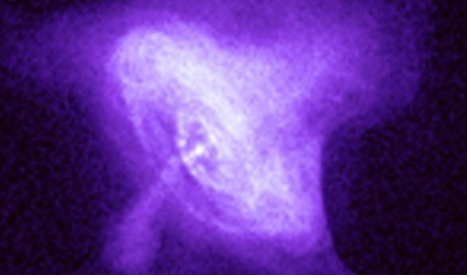
- Area
  - Available power
  - Heat flow
  - Telescope Speed
- Volume
  - Mass
  - Cost
  - Energy Storage



What Science (1)?

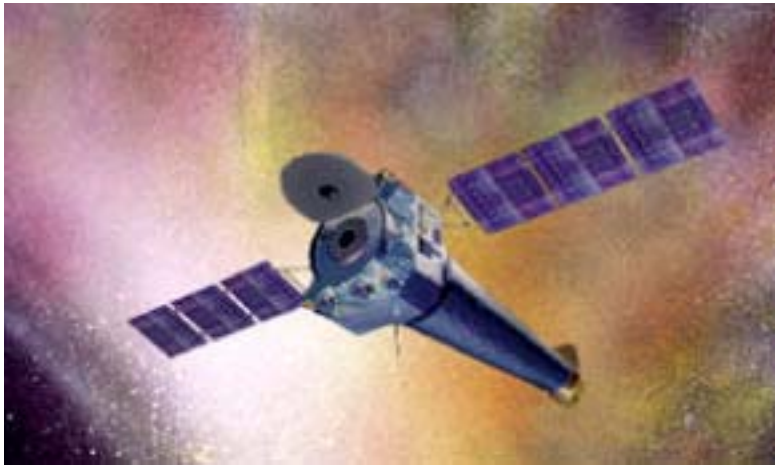
"Eighty percent of success is showing up." -- Woody Allen

- Gamma-ray bursts
  - 100 cm^2 detector enough for faint ones
    - Cosmological studies
  - 1 cm^2 detector enough for bright ones
    - Studies of the burst phenomenon
  - Major driver of detection rate is sky coverage, not detector area
- X-ray all sky monitors
  - RXTE ASM detectors only 60 cm^2
    - Today's Si detectors better QE, resolution, allow shrinkage

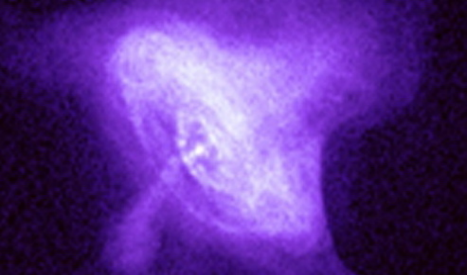


What Science (2)?

A spacecraft should do one thing well (to paraphrase Brian Kernighan)

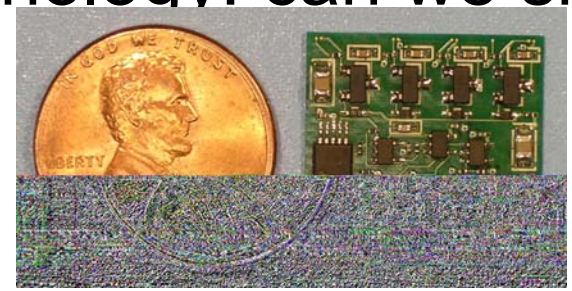


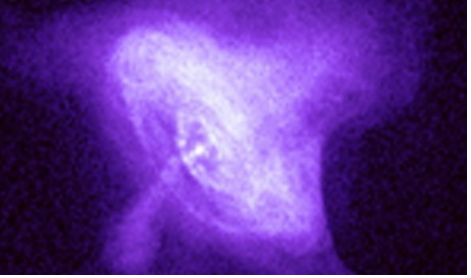
- Chandra
  - Cost ~$4,000,000/cm^2
  - Excellent resolution
    - Heavy inefficient optics
    - Square-cube mechanical difficulties
  - Many observations could exchange time for area
    - Nanosat could concentrate on a single target



What sets the floor?

- Batteries
  - Orbit time scale unchanged, energy needs scale as l^2, energy capacity as l^3
    - NiCd adequate for HETE scale (125 kg)
    - Better batteries now available (nanophosphate Li look very promising)
- Circuits
  - HETE used 1992 technology: can we shrink area and power 25x? Yes:





Conclusion

- In 1992, putting a world-class scientific mission into 125 kg was a challenge.
- In 2008, with the right choice of mission, 1 kg is the challenging scale.
- Keeping costs down is critical.
  - Still need to work out all details of a mission.
  - Need to publish detailed designs and software for reuse by the community.