Soft X-ray Polarimetry using Multilayer Coated Mirrors

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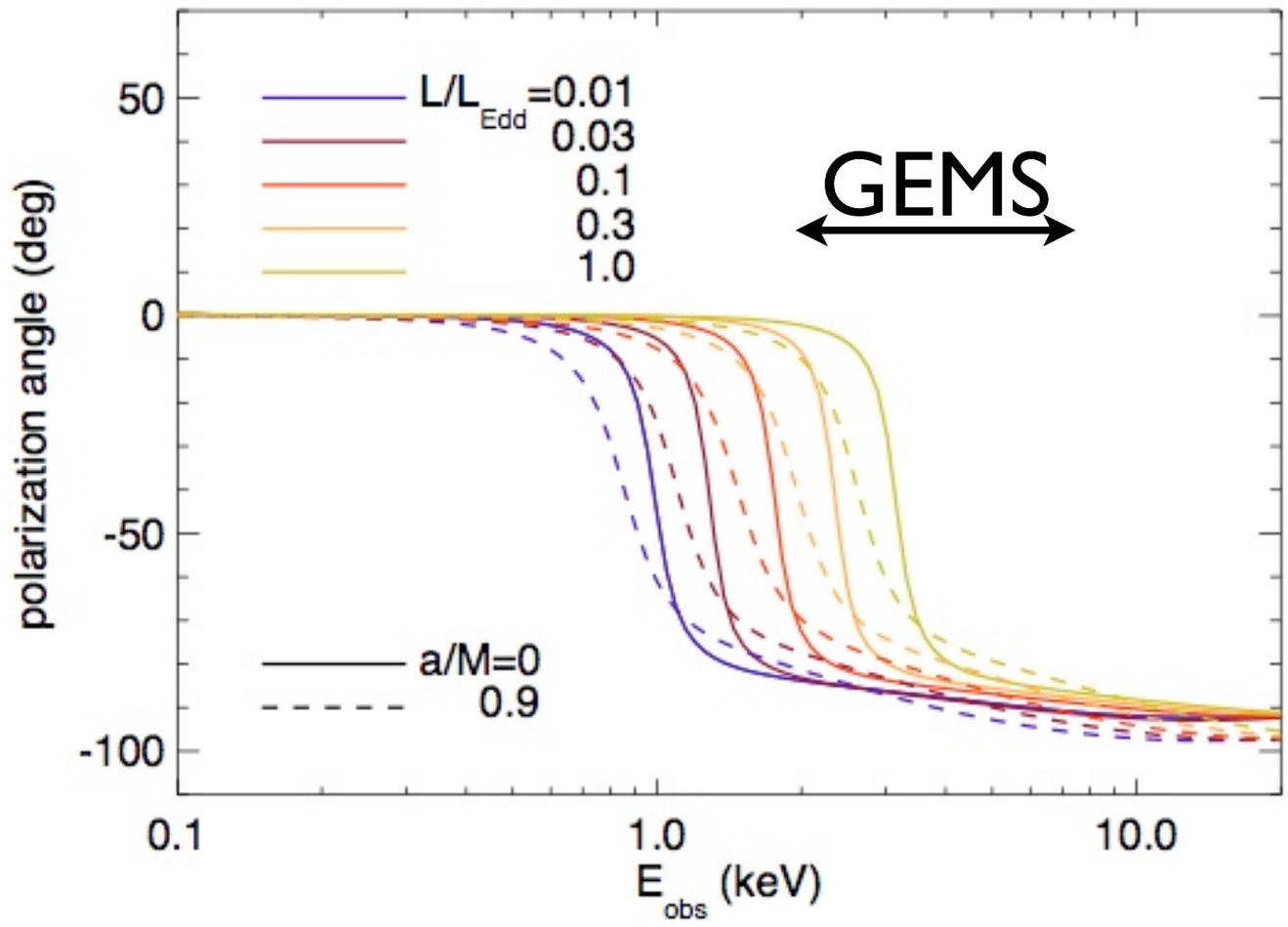
Overview

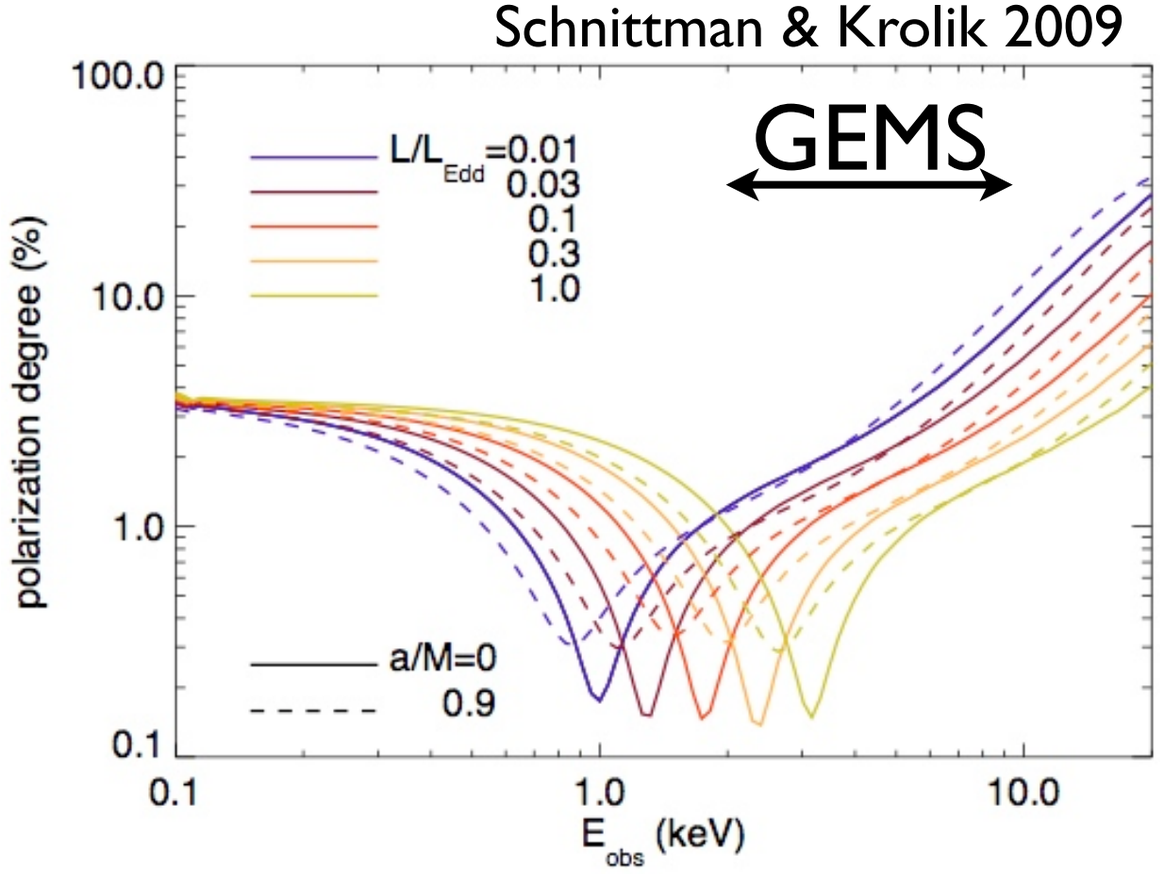
- Goals: measure X-ray polarization from
  - Accretion onto and jets from black holes
  - Strong B-fields of neutron stars
  - Any other scattered or synchrotron emission and propagation in high B
- Concept: Bragg reflection at Brewster angle (45°) completely polarizes
  - Multilayer coatings give high reflectivity in 0.1-1.0 keV band
  - Coatings have narrow bandpasses but polarized light is likely to be a continuum
  - Disperse with gratings to match ML bandpasses to get broad band
- Development: lab work on potential flight components
  - Lab work is funded by NASA APRA for two years
  - Need: better gratings, detailed mission design, ML tech. improvement

Polarimetry of AGN

- Scattered return radiation will be polarized
- Polarization fraction and angle depend on a/M, L/L_{Edd}
- Soft and Hard X-ray measurements are needed

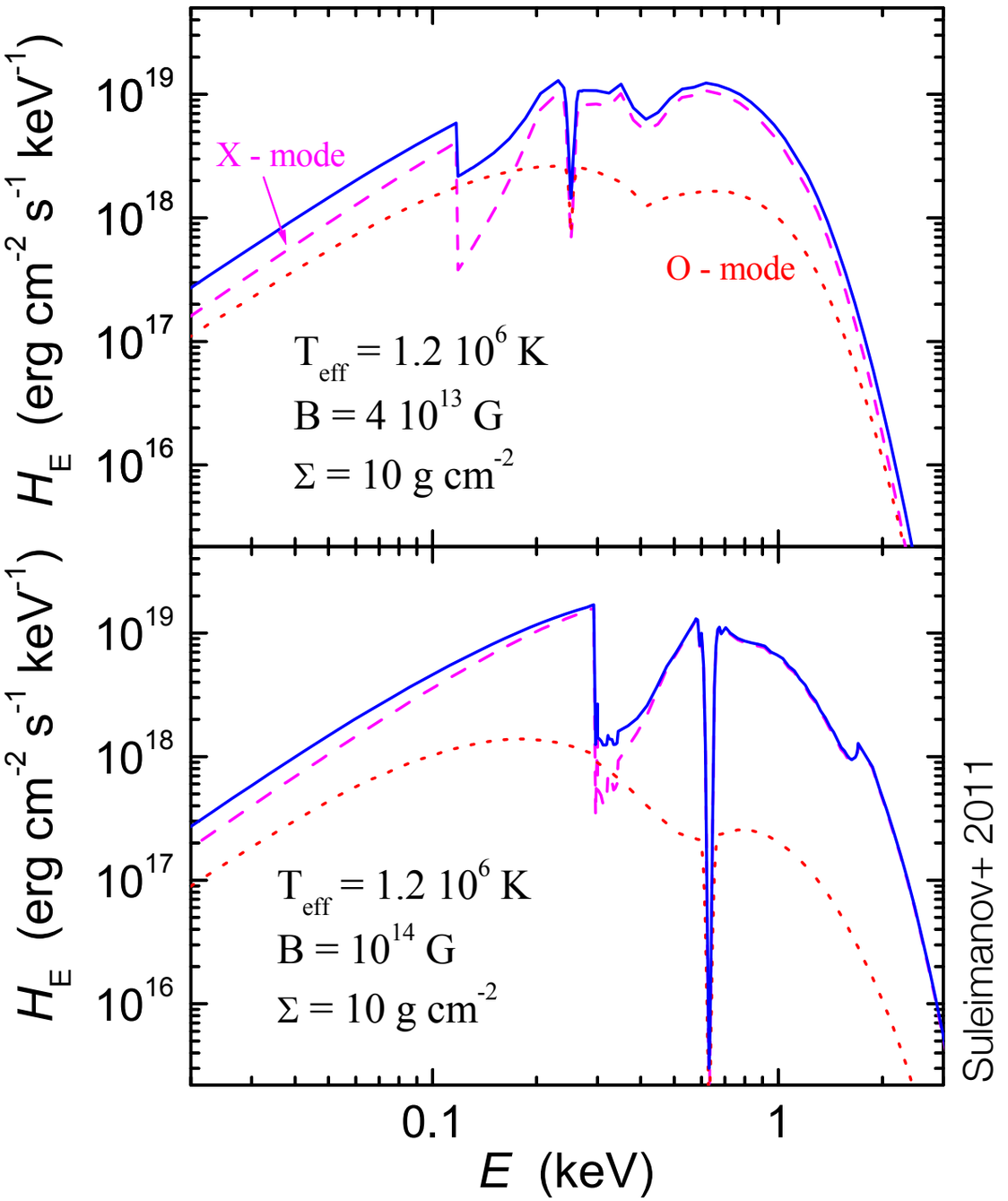


Schnittman & Krolik 2009



Neutron Star Atmospheres

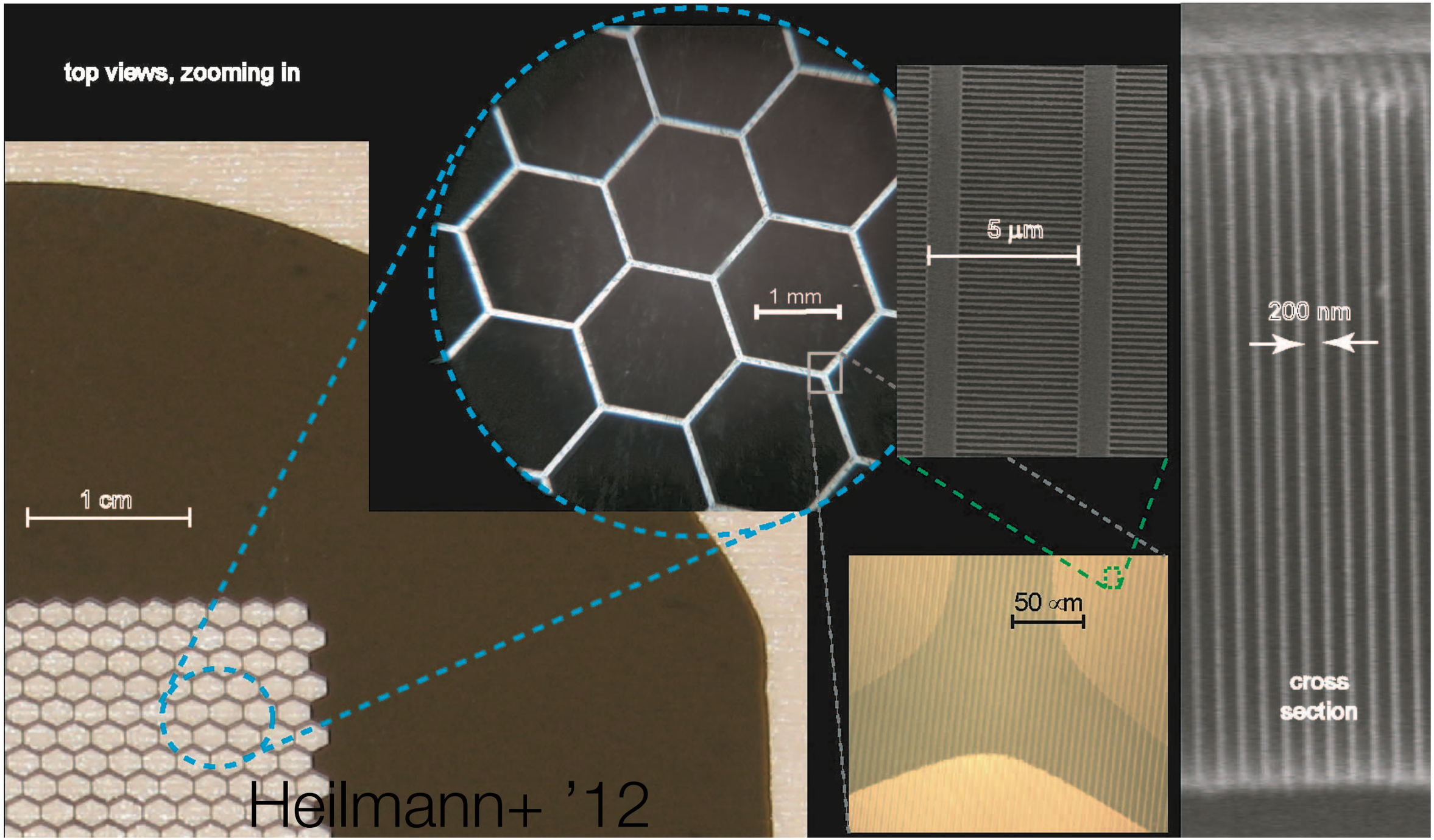
- Isolated neutron stars are often cool, kT < 1 keV
- A few soft X-ray spectra show features
- Polarization distinguishes features in spectra
- Atmosphere models are used to determine R^2, g to give M,R

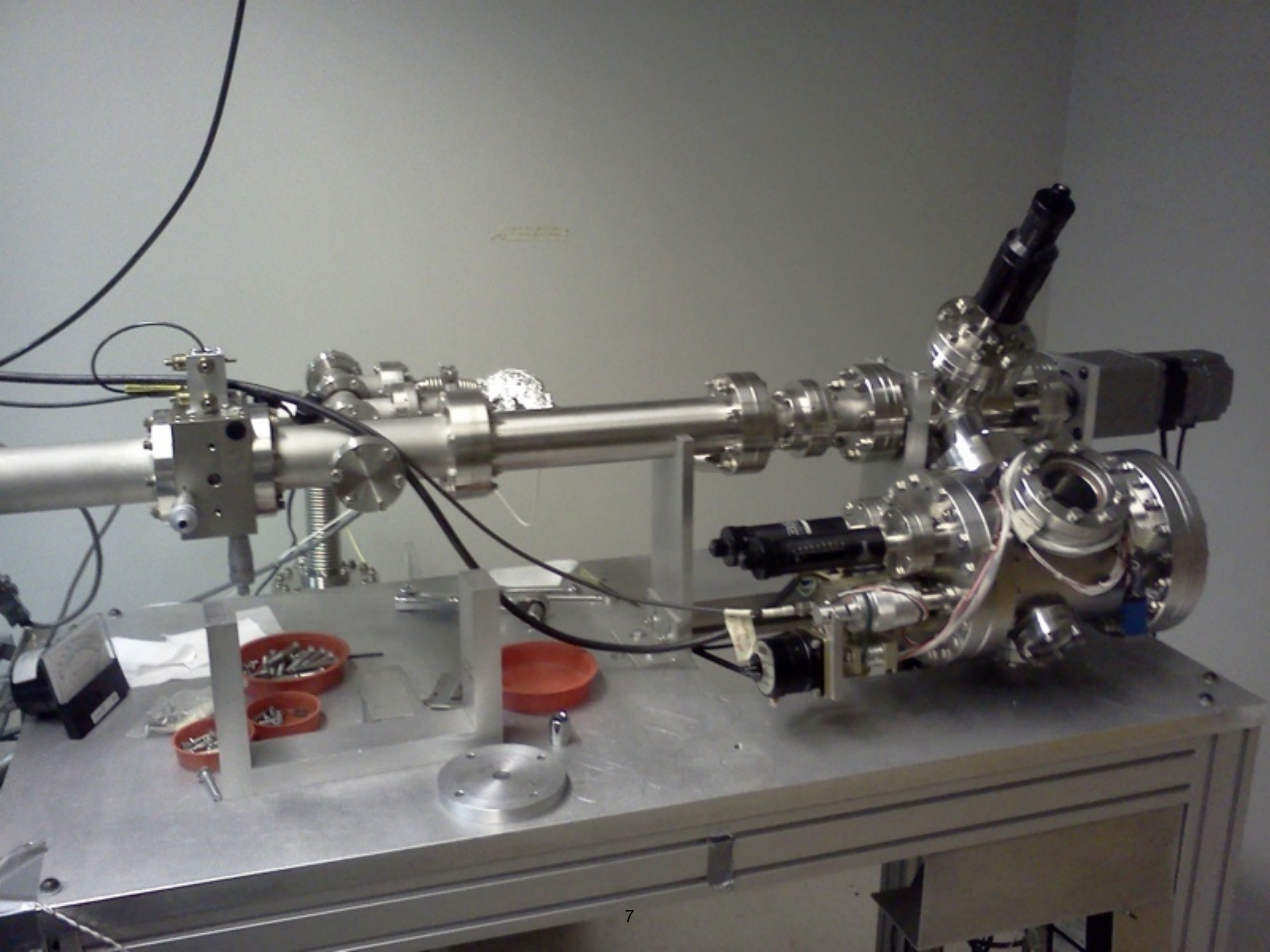


Soft X-ray Polarimetry

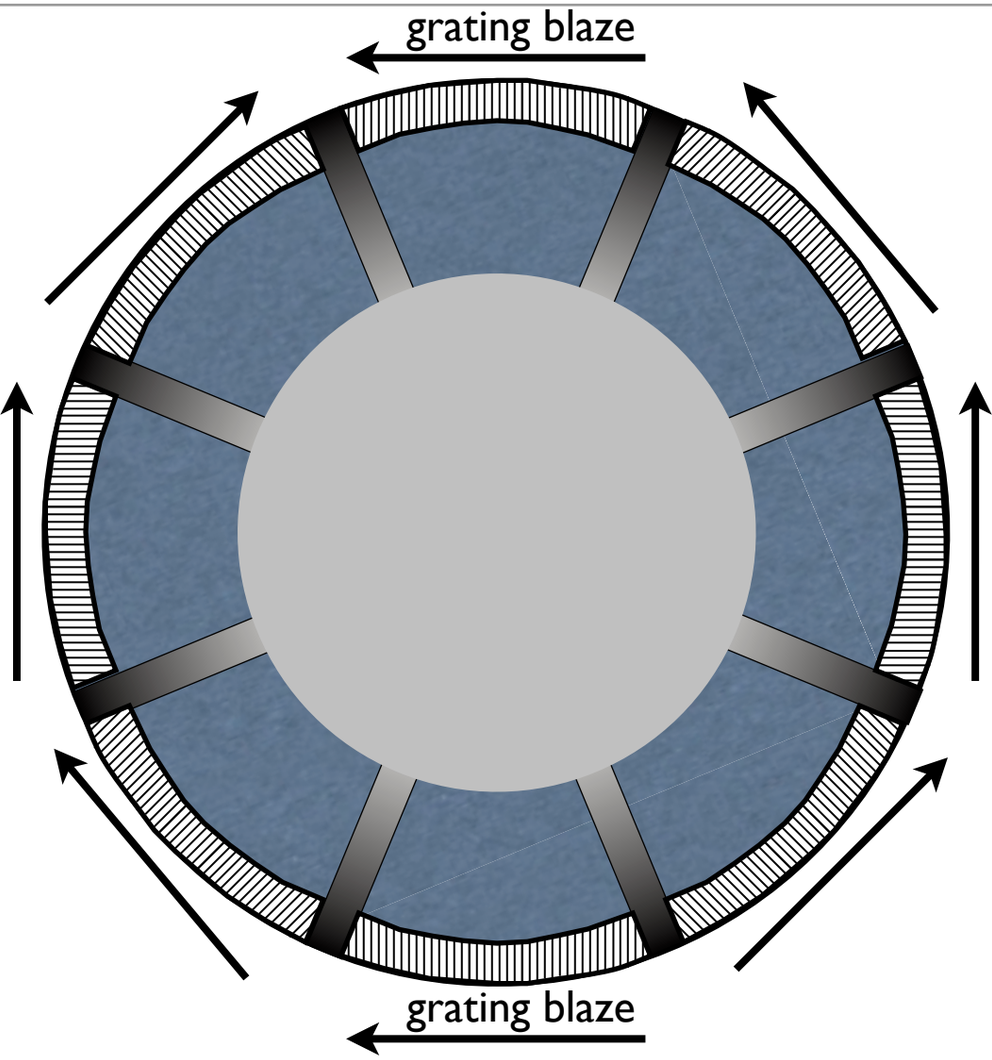
- Start with general use broad-band mirror
- Use (blazed) gratings (NASA SAT funding) to disperse X-rays
- Add Bragg reflector: multilayer (ML) coated, flat mirror
    - Reflect at 45° angle (Brewster angle) to select polarized photons
    - Many layers in ML brings reflectivity to 10-20%
    - Vary ML period along dispersion to match wavelength
- Total bandpass: 0.2-0.7 keV
- Currently testing concept at MIT
    - Kavli seed funding
    - Recent: NASA APRA

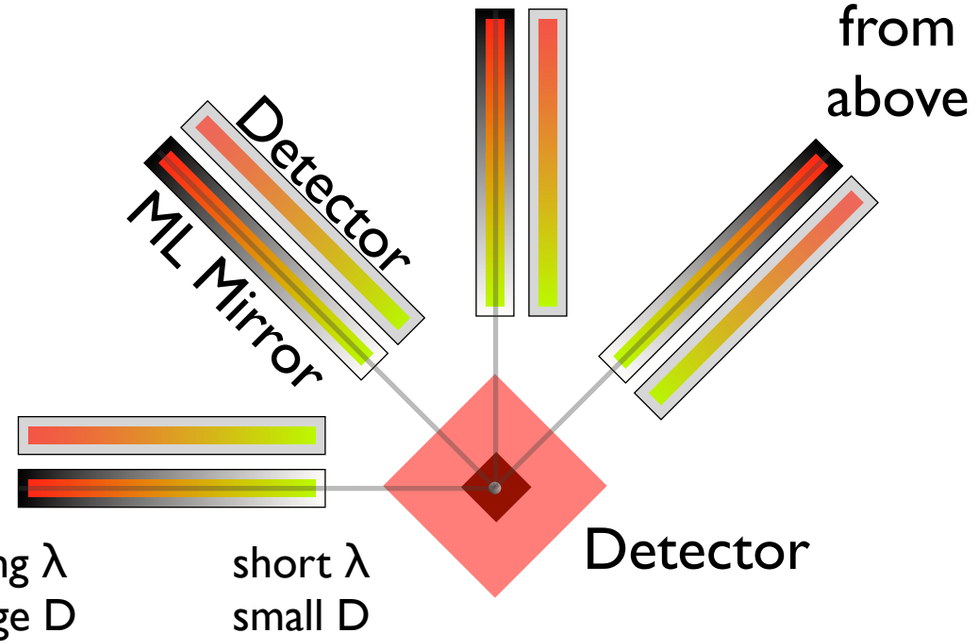
Critical Angle Transmission Gratings

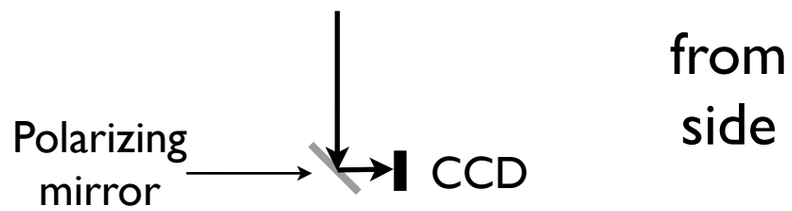


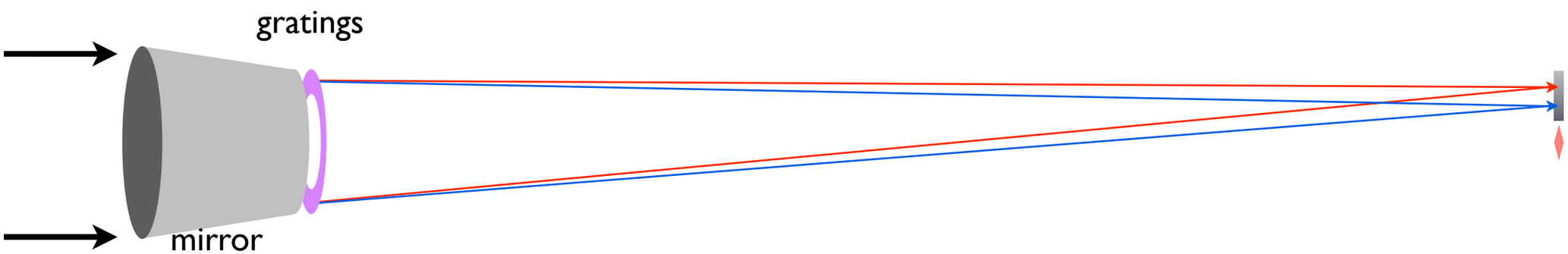


A Soft X-ray Spectropolarimeter Flight Design









Summary

- Feasible goals: measure X-ray polarization from
  - Accretion onto and jets from black holes
  - Strong B-fields of neutron stars
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- Concept: Bragg reflection at Brewster angle (45°) completely polarizes
  - Multilayer coatings give high reflectivity (E < 0.8 keV)
  - Disperse with gratings to match ML bandpasses for broad band
- Development: lab work on potential flight components
  - Lab work is funded by NASA APRA for two years
    - testing efficiency, accuracy of graded ML coatings
  - Need: CAT grating X-ray tests, tolerance analysis
  - Mission design: suborbital is tough, “Explorer-Lite” could work