γ-rays from accretion-powered X-ray binaries

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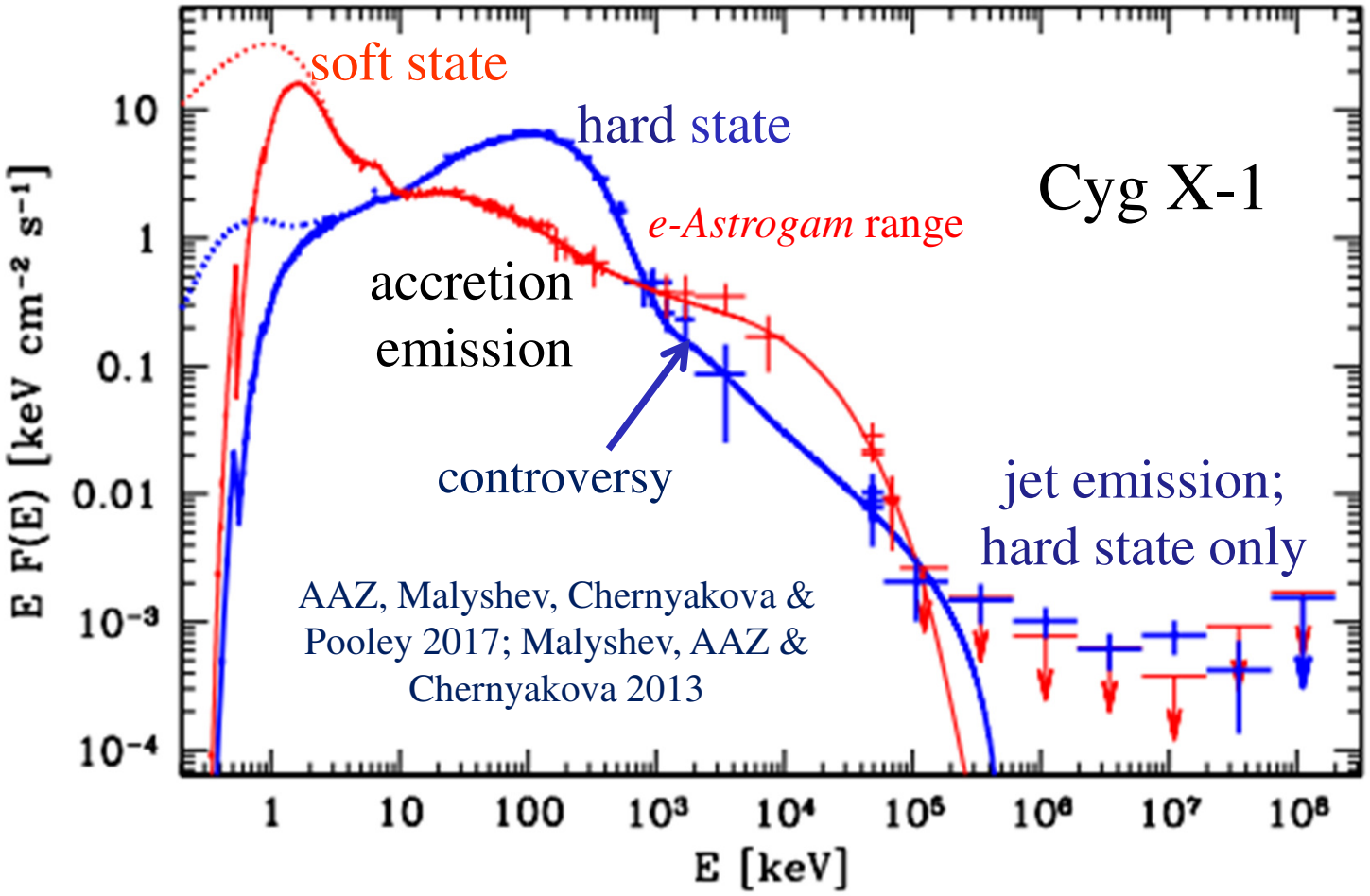
1. Particle acceleration in accretion flows and jet structure

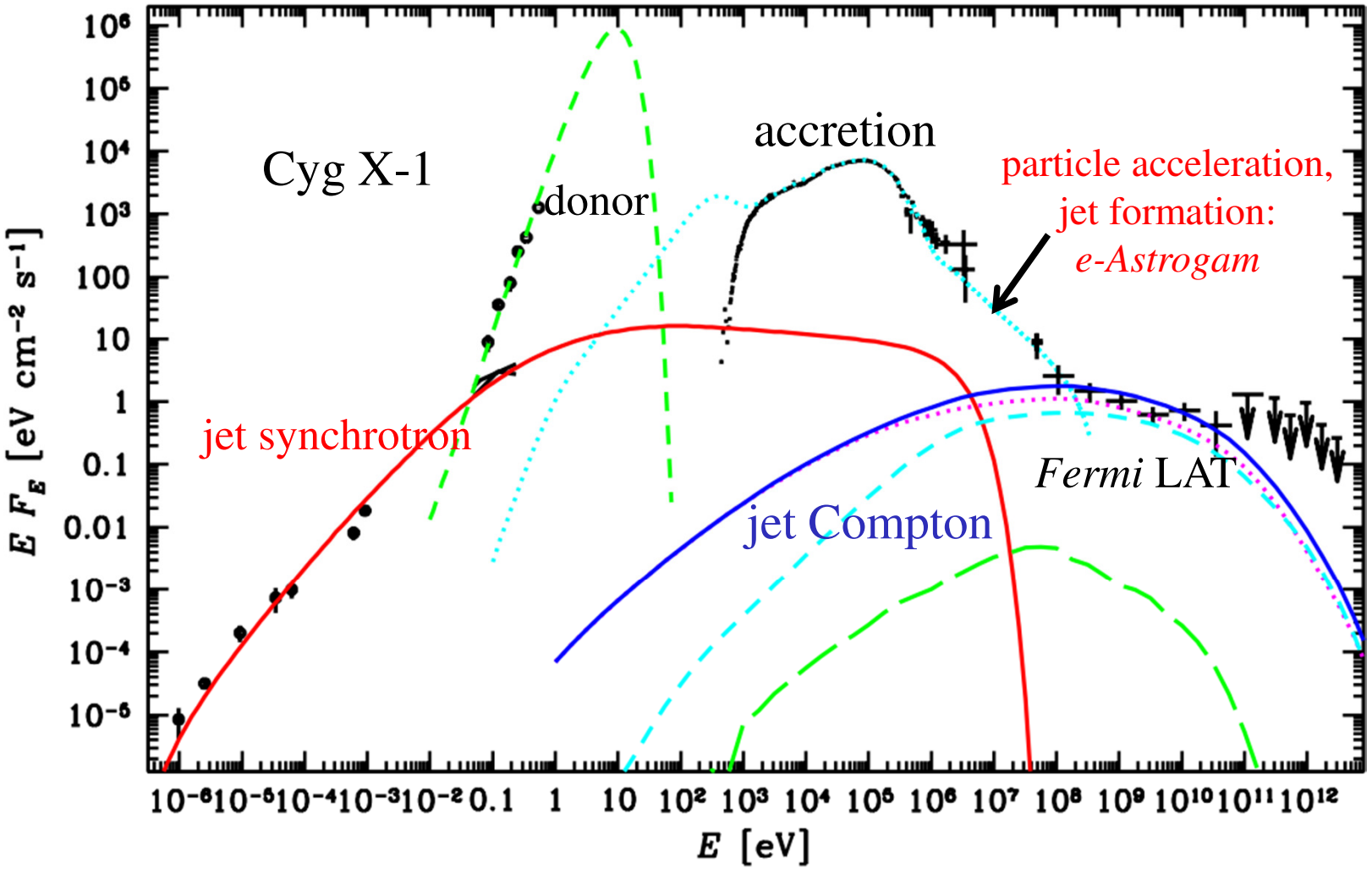
Cyg X-1, a black hole+OB supergiant



- MeV tails in both states – poorly determined. Are hadronic processes important?
- High-energy γ-rays: hard state only (Malyshev+13, Bodaghee+13; Zanin+16, AAZ+17); emitted by a jet.
- AAZ+17: soft emission at <100 MeV; the flux in the soft state > the hard state, matching the extrapolations of two previous accretion models of particle acceleration in a magnetized accretion flow.

The broad-band spectrum

Jet model: electron acceleration, cooling, advection, radiative processes; γ-ray emission from SSC and Compton scattering of stellar blackbody and a disc.



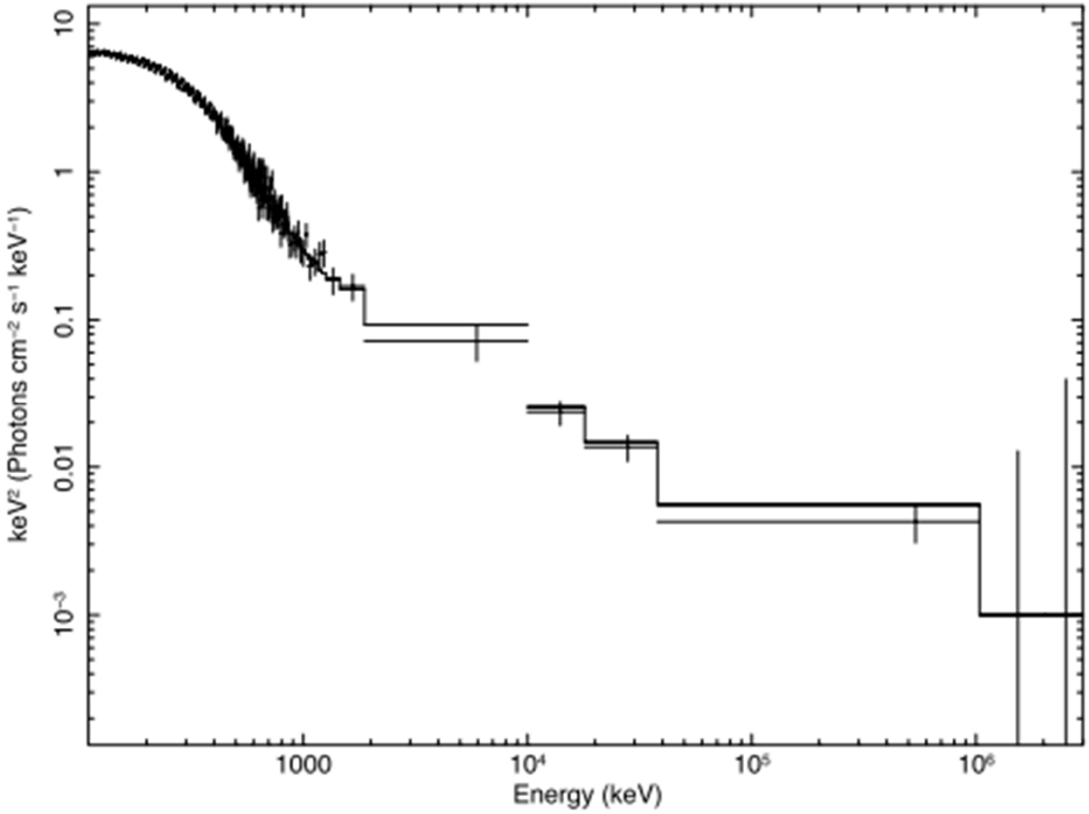
AAZ+ 2014a,b, 2017

Very strong 0.2–2 MeV polarization claimed from *INTEGRAL* in the hard state of Cyg X-1

- Laurent+11 (*Science*) and Rodriguez+15 (*ApJ*) claim linear polarization of ~70% above 400 keV; also Jourdain+12.
- If it is real, it is likely to be synchrotron jet emission.
- A revision of the results of Laurent+11 given by Laurent (2016, *INTEGRAL* conference presentation), but no publication.
- The presence of the polarization was to be tested by the SGR detector onboard *Hitomi*.
- Will be studied by *e-Astrogam*.

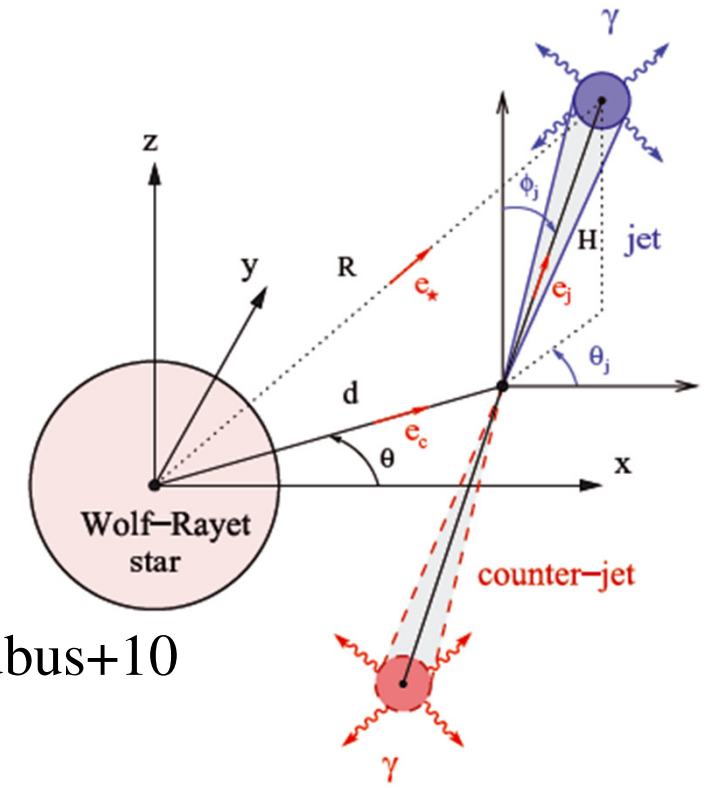
Simulations of *e-Astrogam* measurements

- Cyg X-1 in 10^5 s. S/N ratio above 0.5 MeV of ~10^2. A detection up to several MeV in 10^3 s with the significance equal to that of *INTEGRAL* in 2×10^6 s.
- In 10^6 s, the minimal polarization measurable at >500 keV with 99% confidence will be 5%.

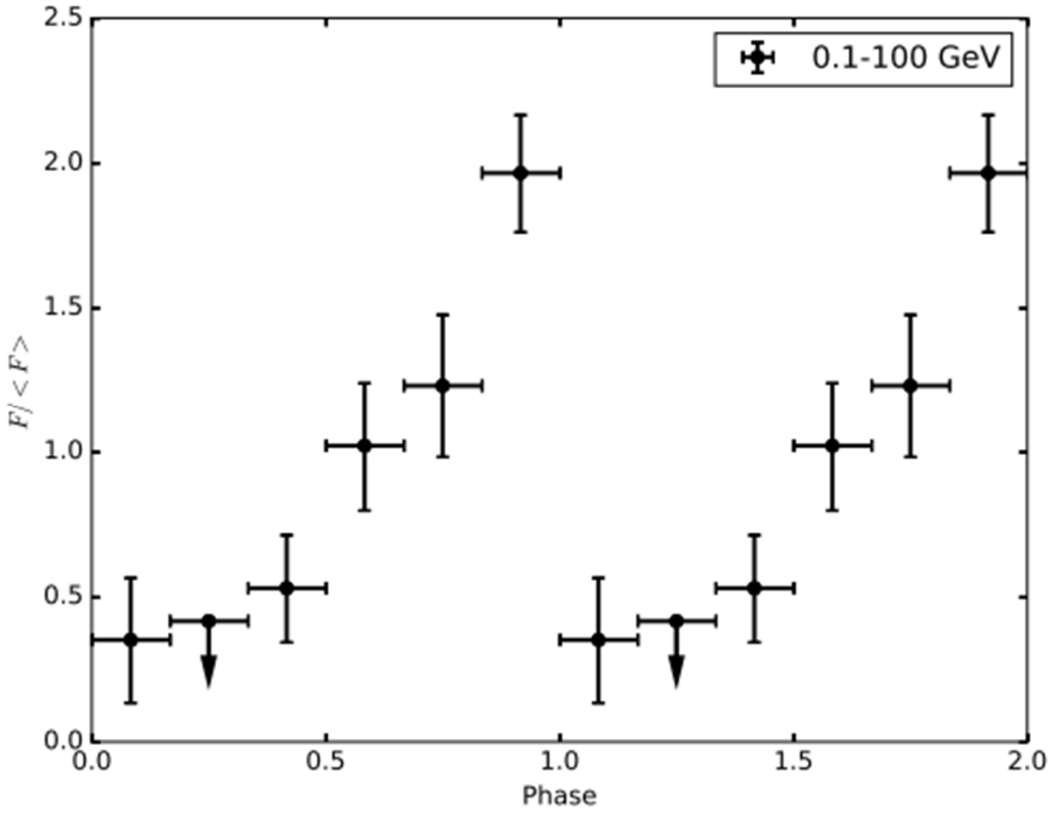


Cyg X-3: a HMXB with unknown compact object. γ-ray emission in the soft state with strong orbital modulation

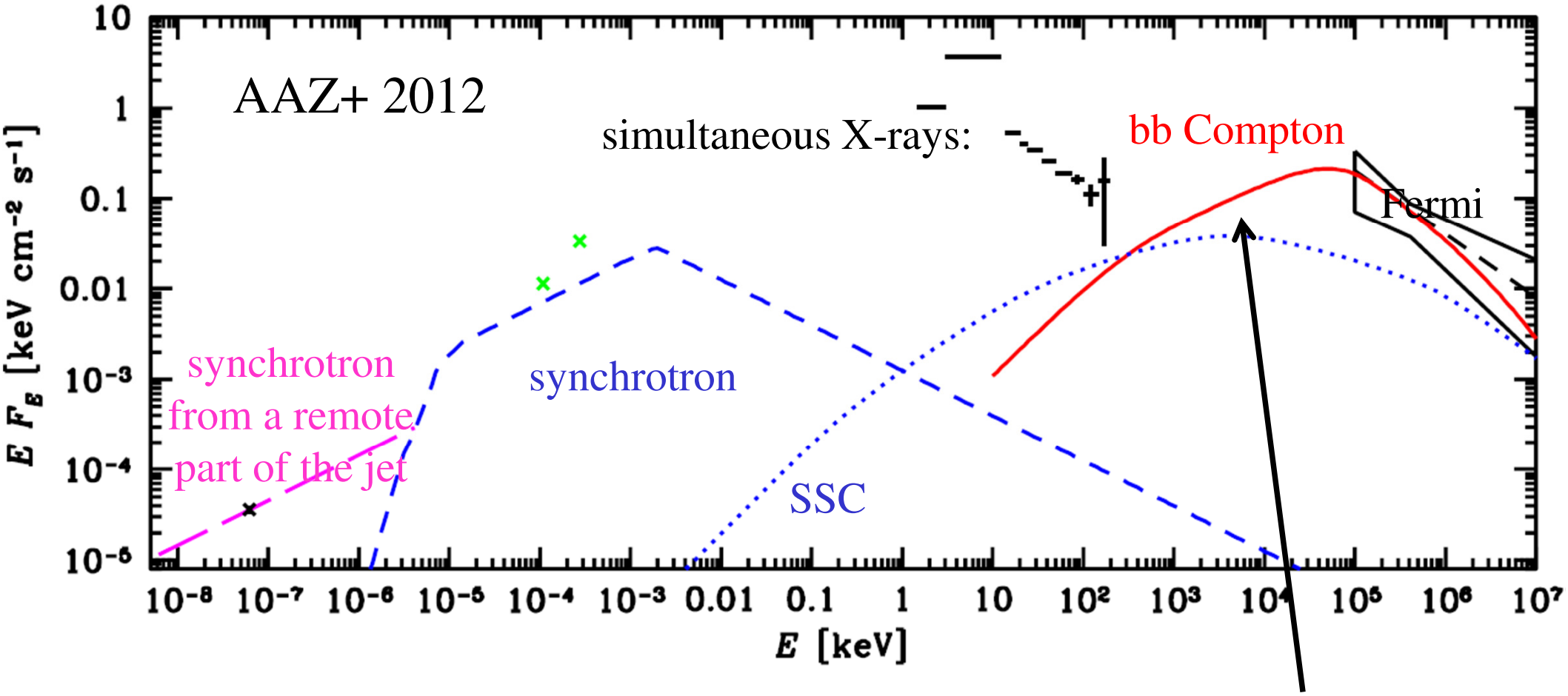
- γ-rays probably from Compton upscattering of stellar blackbody photons due to the Compton anisotropy – but not proven yet.



Dubus+10



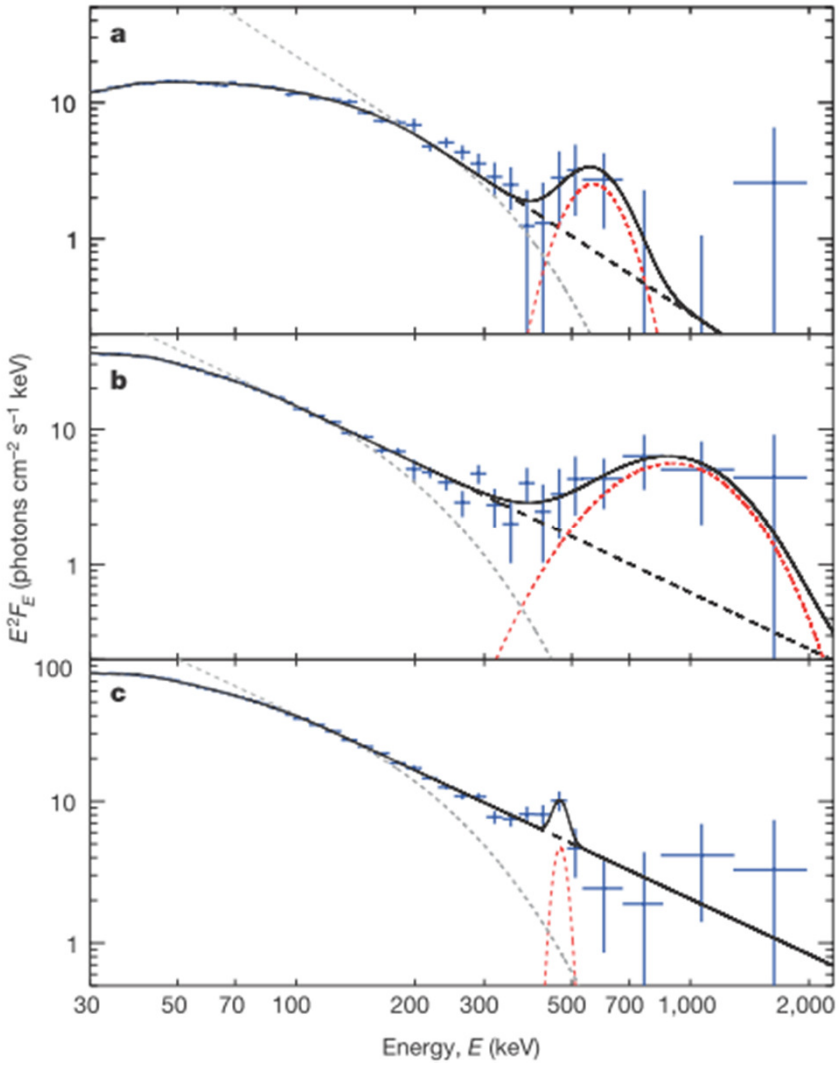
The broad-band spectrum the soft state in Cyg X-3:



The MeV-range spectrum: transition from the spectrum dominated by accretion to that jet-dominated; to be investigated by *e-Astrogam*

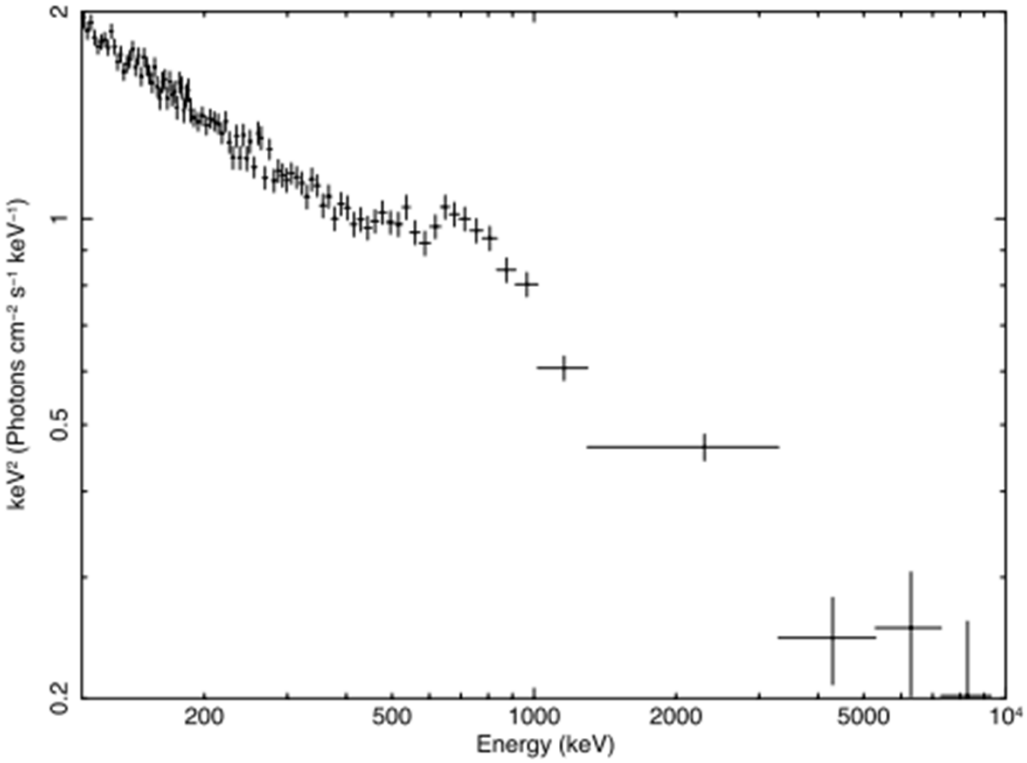
$e^{\pm}$ pair-plasma physics: pair production in the accretion flow and jet composition

Strong $e^{\pm}$ pair annihilation spectra from V404 Cyg and a simulation



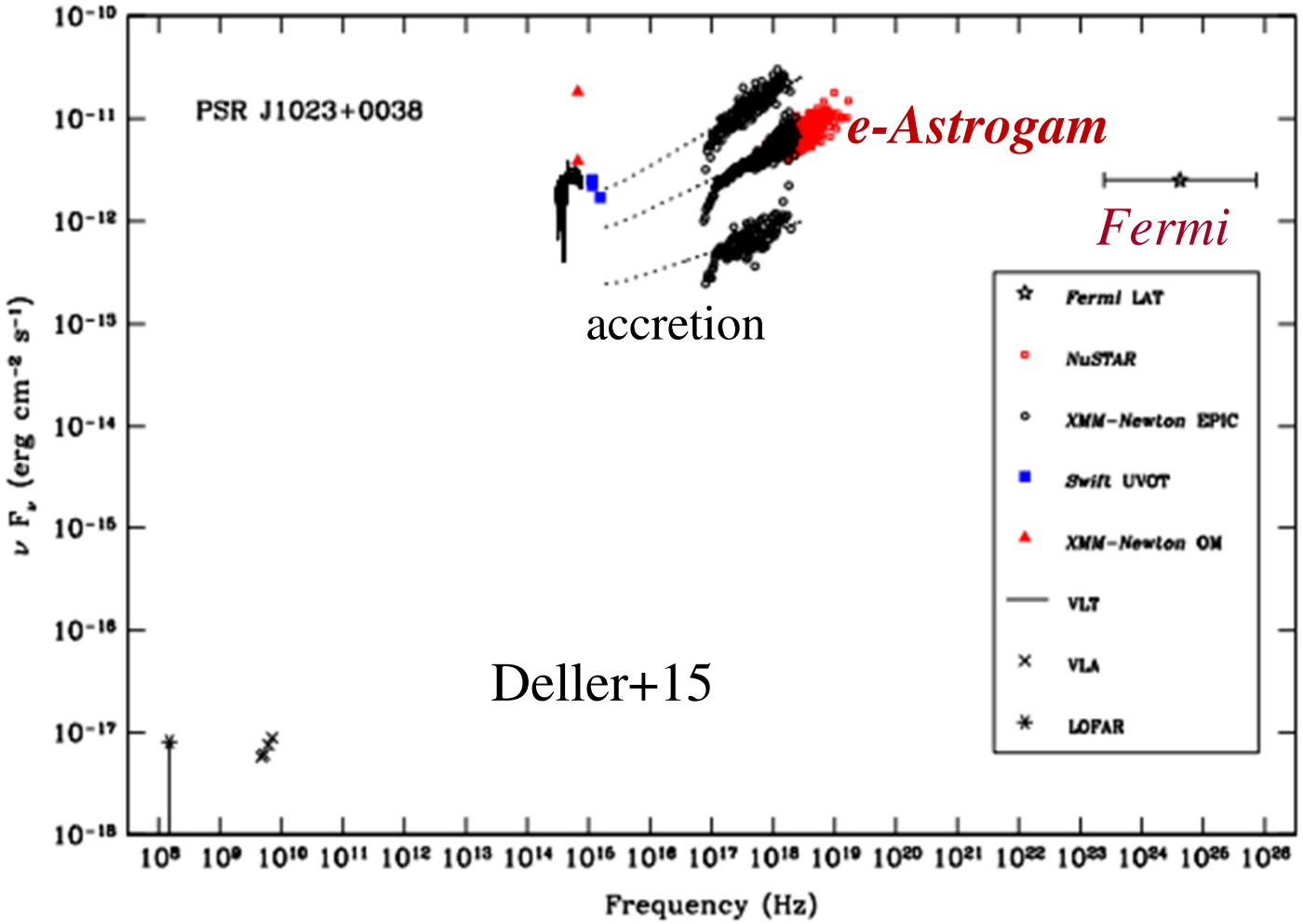
Siebert, Diehl+16

The flux several times lower than in V404, 10^5 s, S/N ratio of the line with EW≈100 keV of ~30.



Transitional pulsars – physics of the change between rotation-powered and accretion-powered states

The broad-band spectrum of PSR J1023+0038 in a weak accretion state



The nature of the γ-rays: either interaction of the accretion disc with the pulsar wind, a propellering magnetosphere, or a jet. Data on the connection between the X-ray and γ-ray regimes can resolve this issue.

Main issues

- Intersection of the accretion and jet components in microquasars, MeV tails: electron acceleration in accretion flows, synchrotron and Compton in jets, polarization.
- Orbital modulation: jet geometry, seed photons from stellar blackbody.
- The presence of $e^{\pm}$ pairs: pair production in accretion flows and jets?
- Transitional pulsars: is the enhanced γ-ray emission in the accretion states related to accretion or to the pulsar mechanisms?
- Expected detection of many LMXBs in γ-rays.