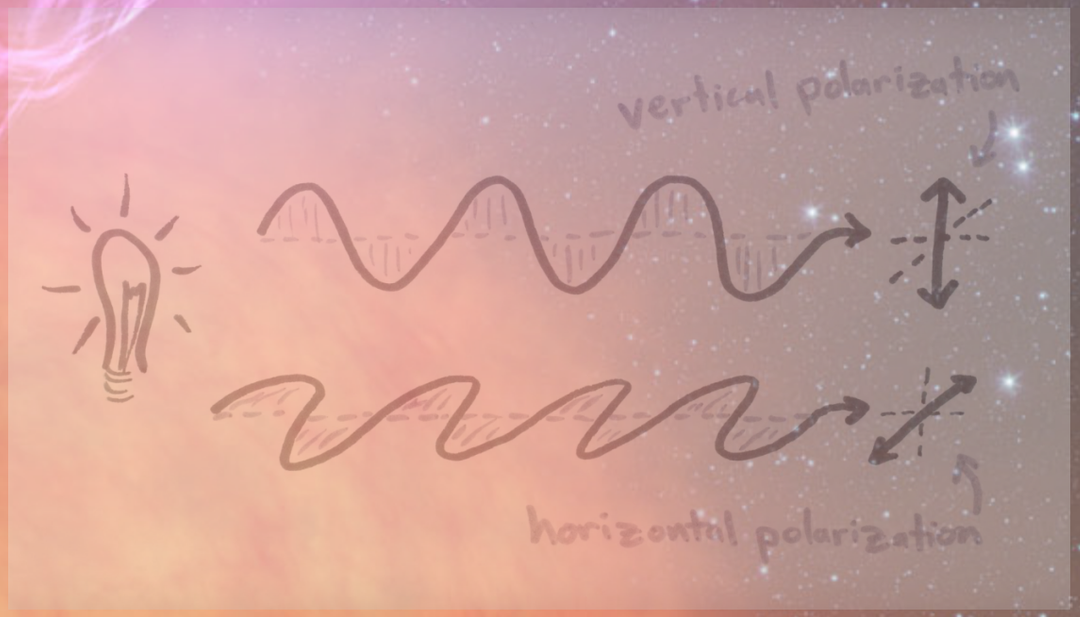
X-ray polarization
as a tool to understand coronae in accreting sources

Francesco Tamborra

collaborators:
G. Matt, S. Bianchi, R. Goosmann
M. Bursa, M.Dovciak



Alsatian workshop on X-ray polarimetry - Strasbourg, 13th-15th/11/2017

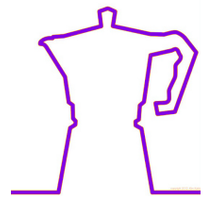
STRONGGRAVITY
EU FP7-SPACE research project 312789 2013 - 2017

asu Astronomický ústav AV ČR

Outline

- MoCA in a nutshell
- X-ray polarization is complex
- The theoretical signal in different scenarios
- Observational prospects
- Conclusions & Future developments

MoCA: a Monte Carlo code for Comptonization in Astrophysics



- single-photons source-to-observer class (Fortran2003)

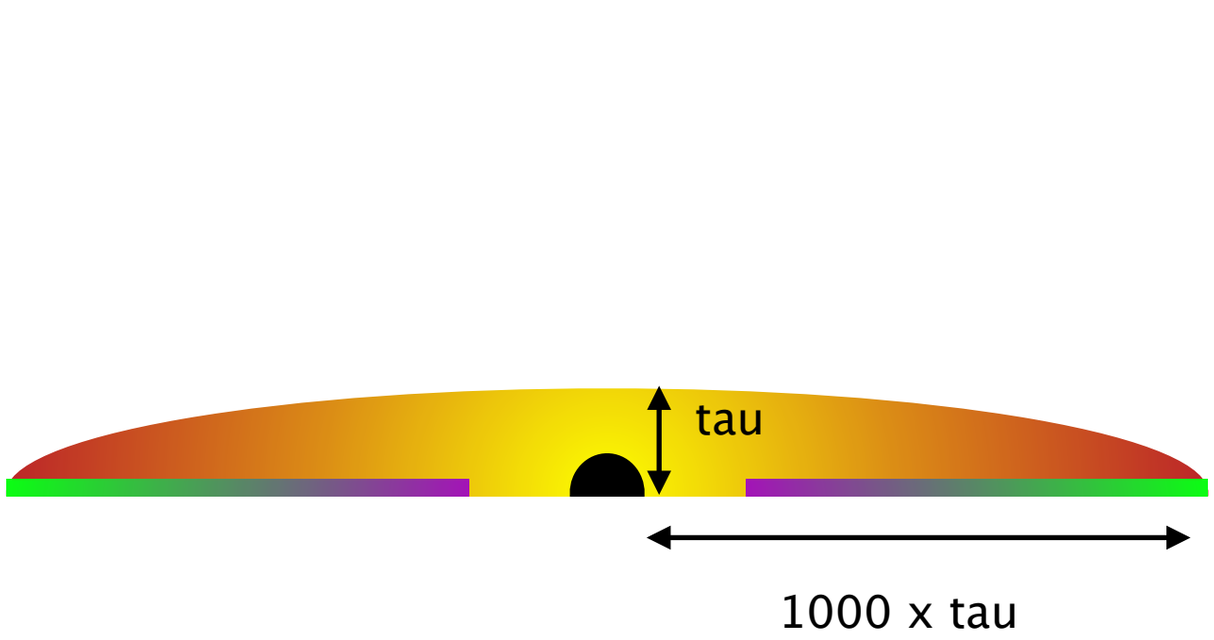
- complete special relativistic and quantum treatment of Comptonization
(Maxwell-Juttner distribution, KN cross-section & scattering angle distribution)

- complete GR description
(N-T disk, ray-tracing A-to-B, frame dragging)

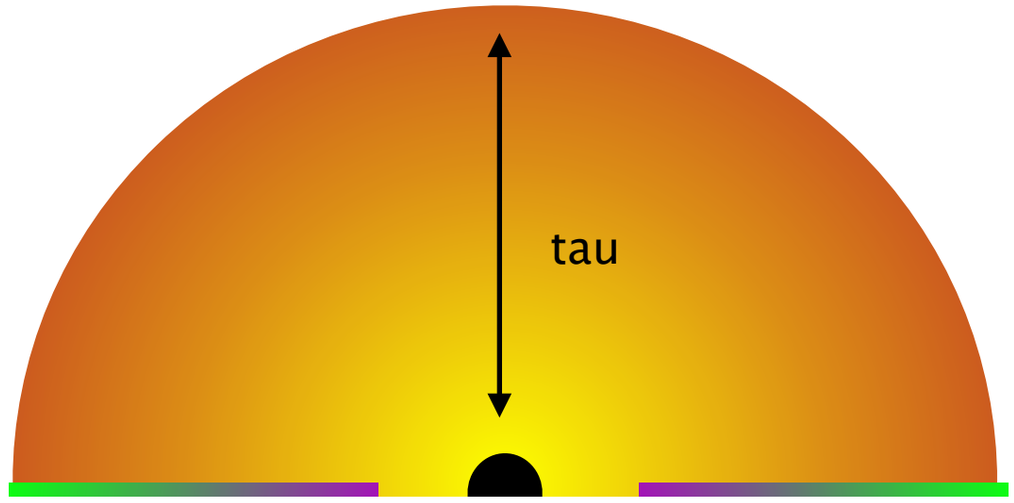
- parallelisation & interoperability with C

- modular and easily customisable

Geometries in this talk



SLAB



SPHERE

source parameters

MBH = 10 Msun
mdot = 0.1 (Edd)

a = 0 / 0.998
limb darkening ON/OFF

corona parameters

kT = 100 keV

geometry SLAB/SPHERE
tau = 0.5/1/2

source parameters

MBH = 10 Msun
mdot = 0.1 (Edd)

a = 0 / 0.998
limb darkening ON/OFF

```
photons BH  =    0.0000000000000000       %
photons disc  =    40.079922177797634       %
photons escaped  =    59.920077822202366       %
    - photons escaped without scatterings =    45.703730106526983       %
    - photons escaped 1 scattering =    21.811584536367246       %
    - photons escaped 2 scattering =    13.132952453387409       %
    - photons escaped 3 scattering =    7.9157220790942784       %
    - photons escaped 4 scattering =    4.7218875253750205       %
    - photons escaped 5 scattering =    2.7920075188119124       %
    - photons escaped >5 scattering =    3.9221157804371543       %
```

corona parameters

kT = 100 keV

geometry SLAB/SPHERE
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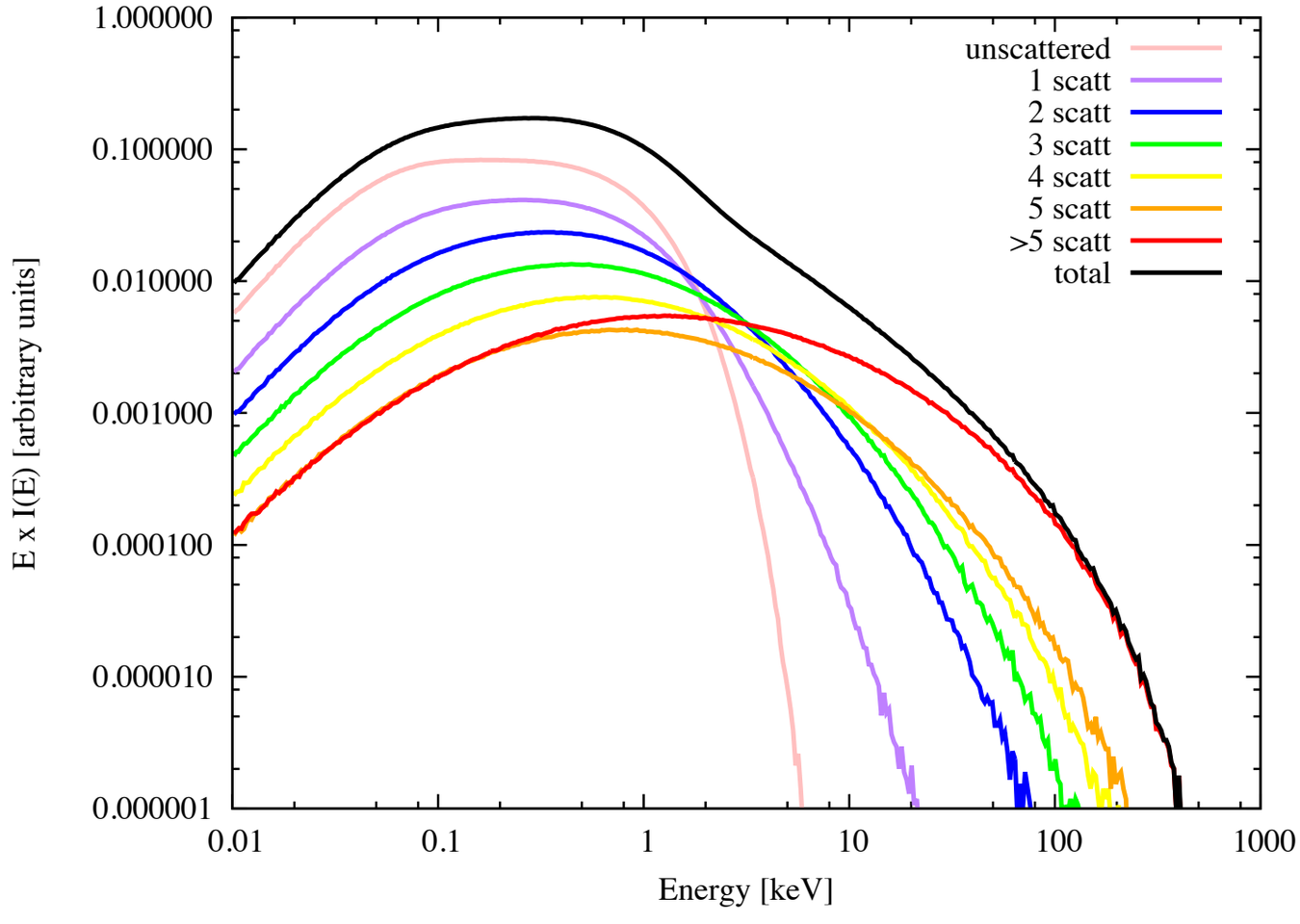
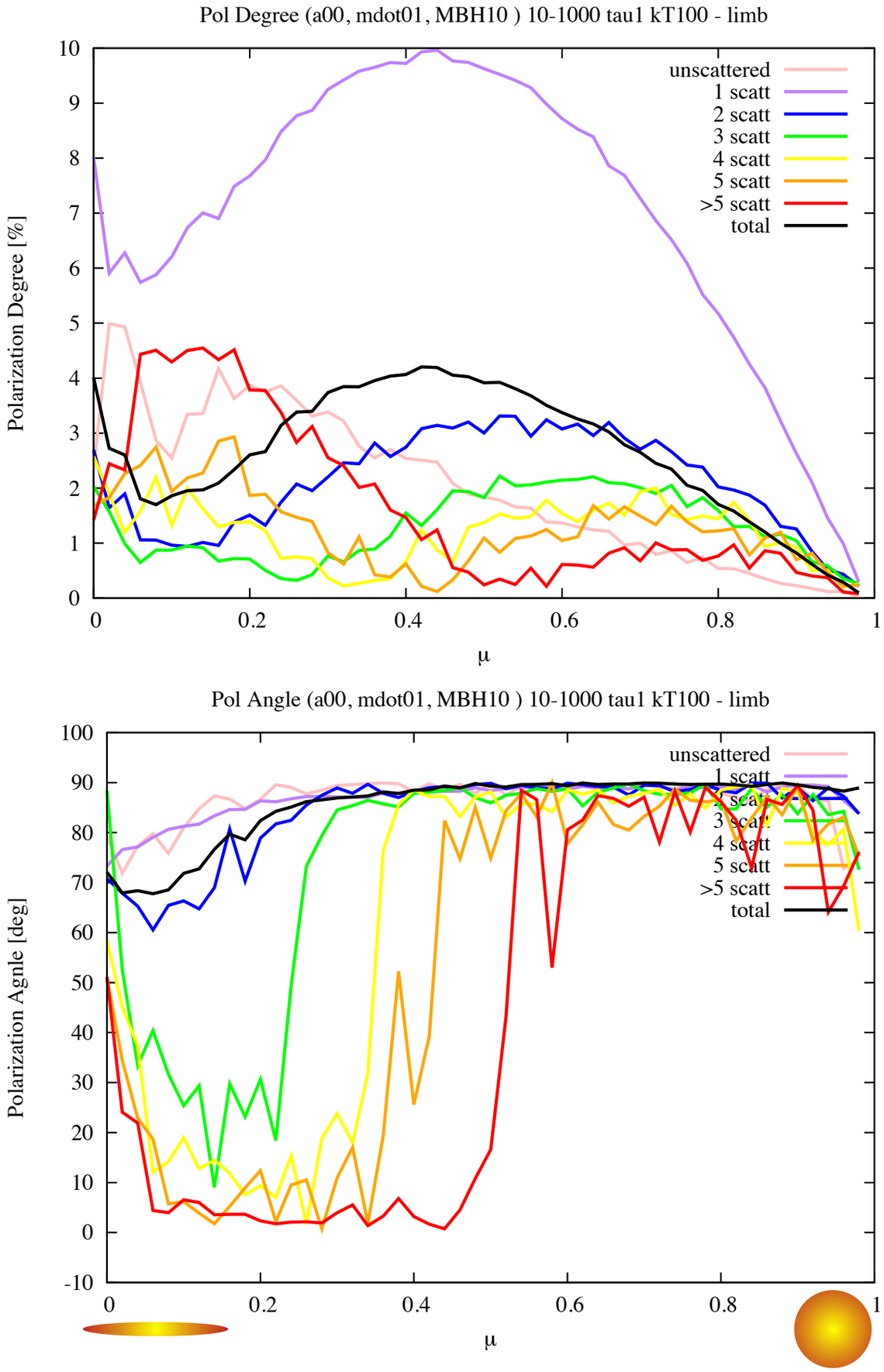


X-ray pol is complex

a0 limb / SLAB tau1



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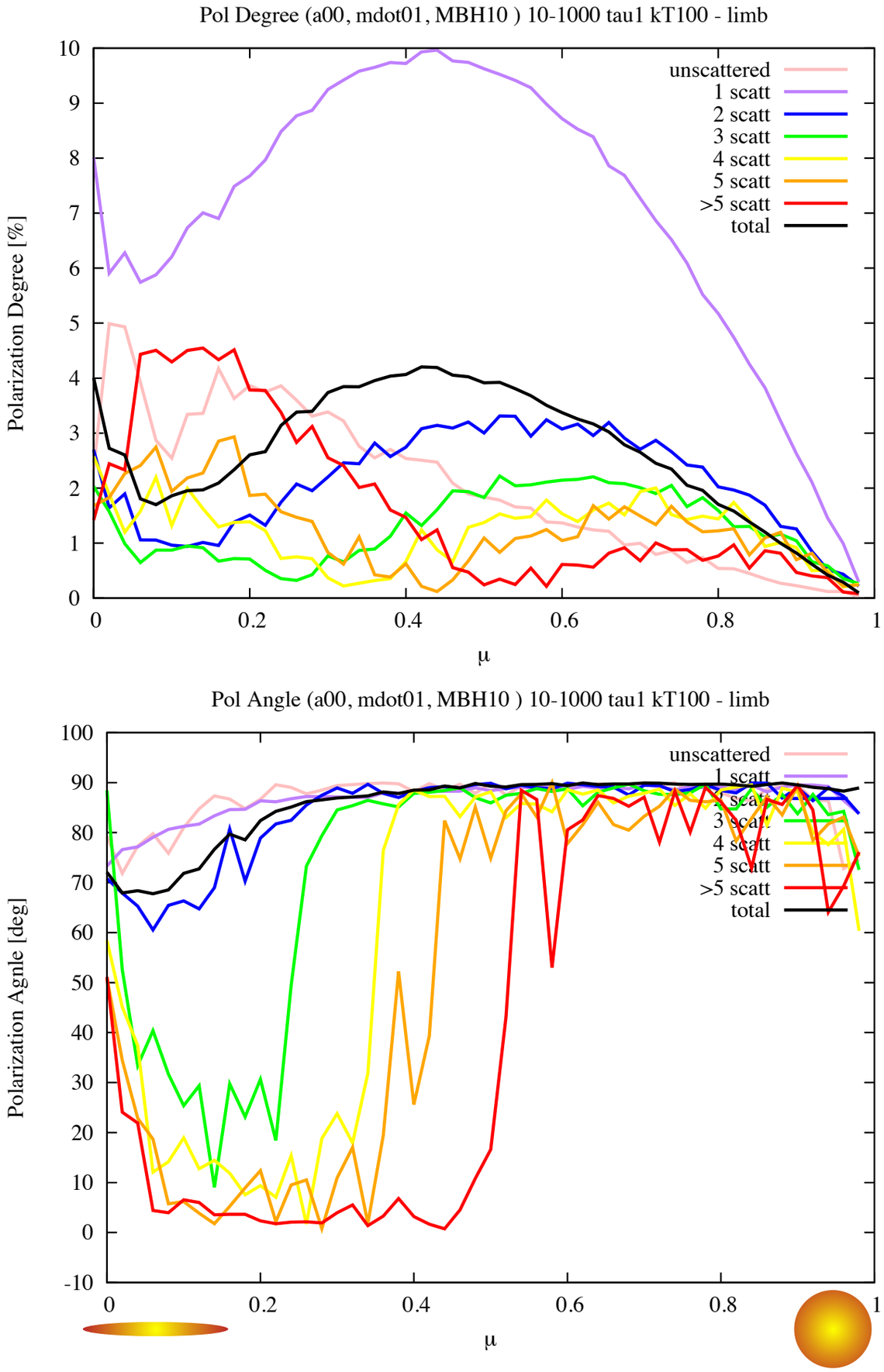

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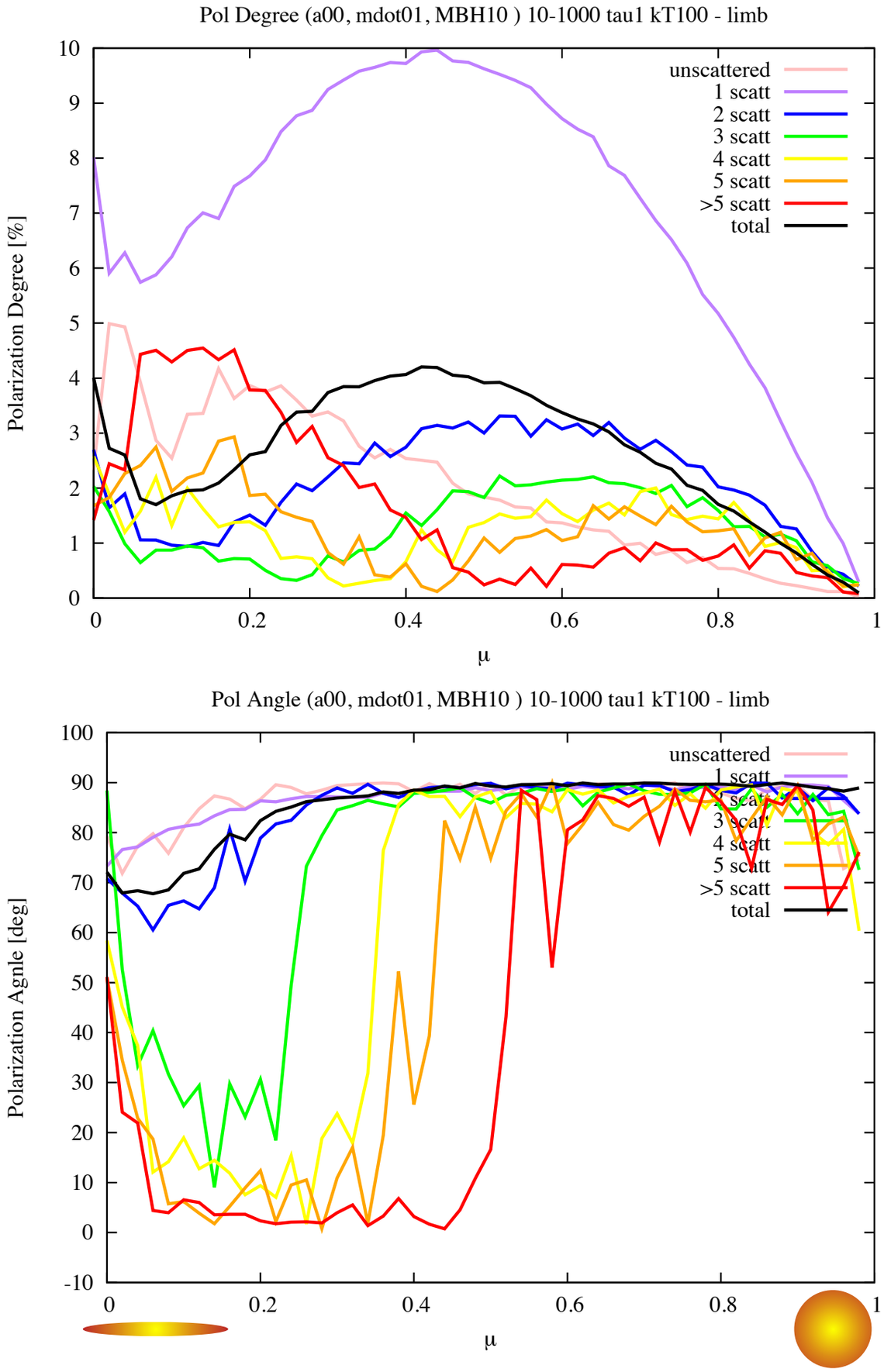

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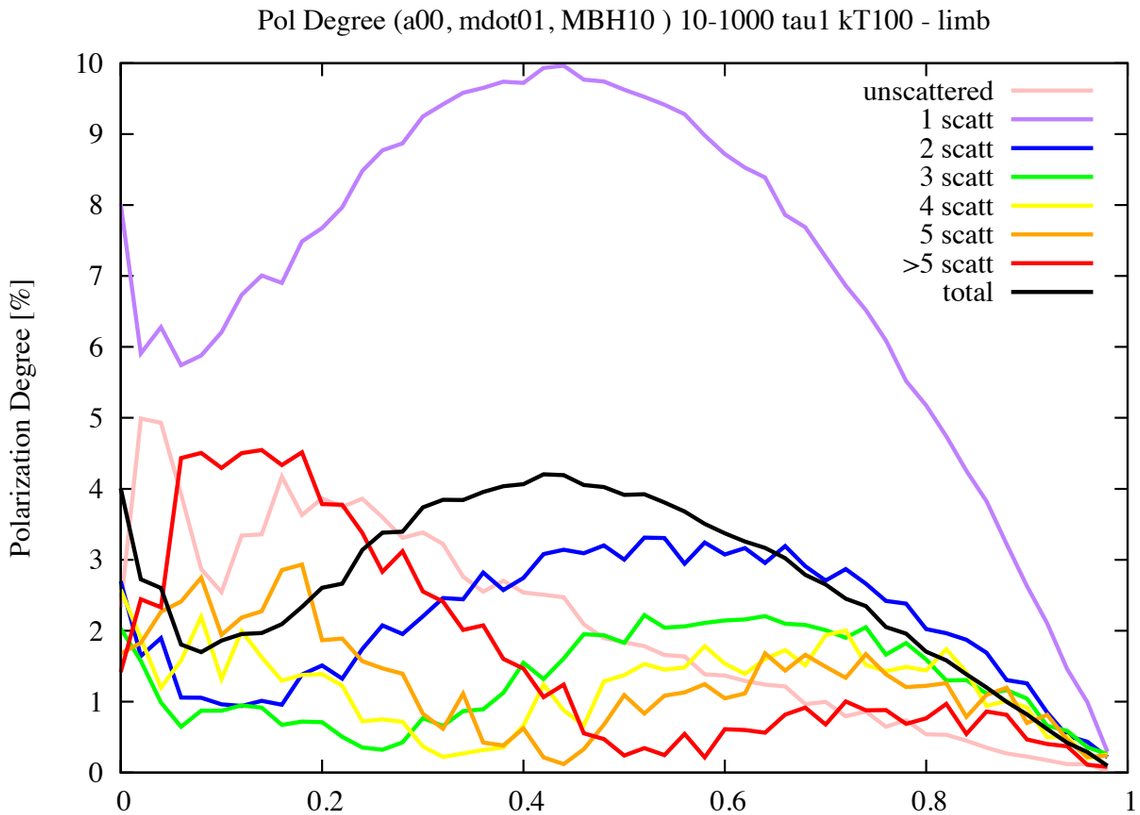
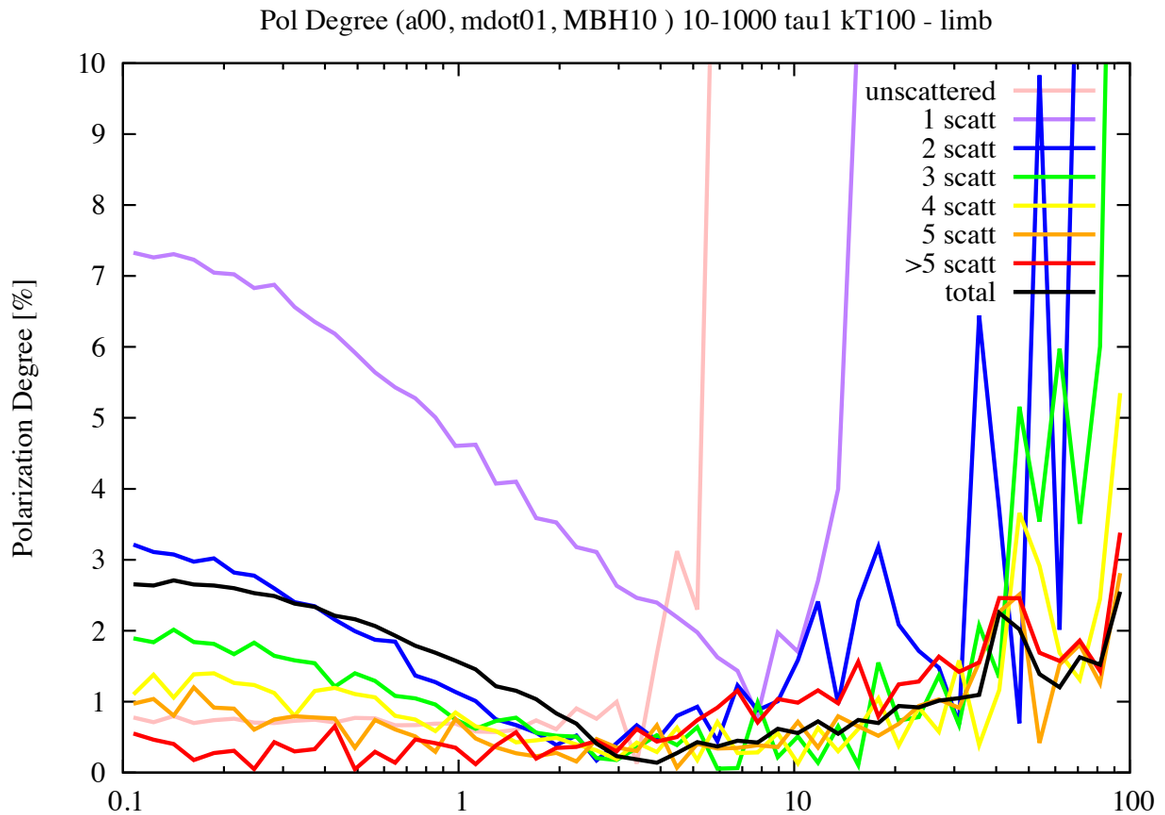
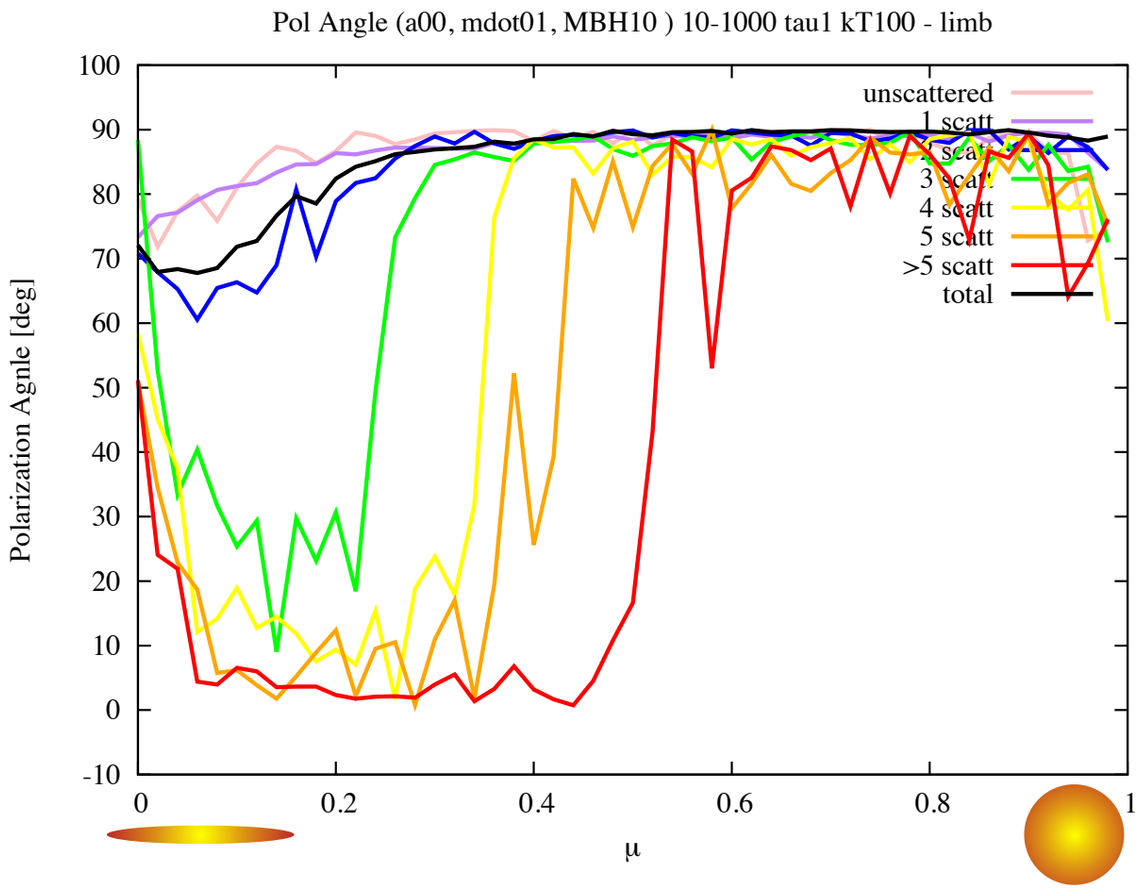
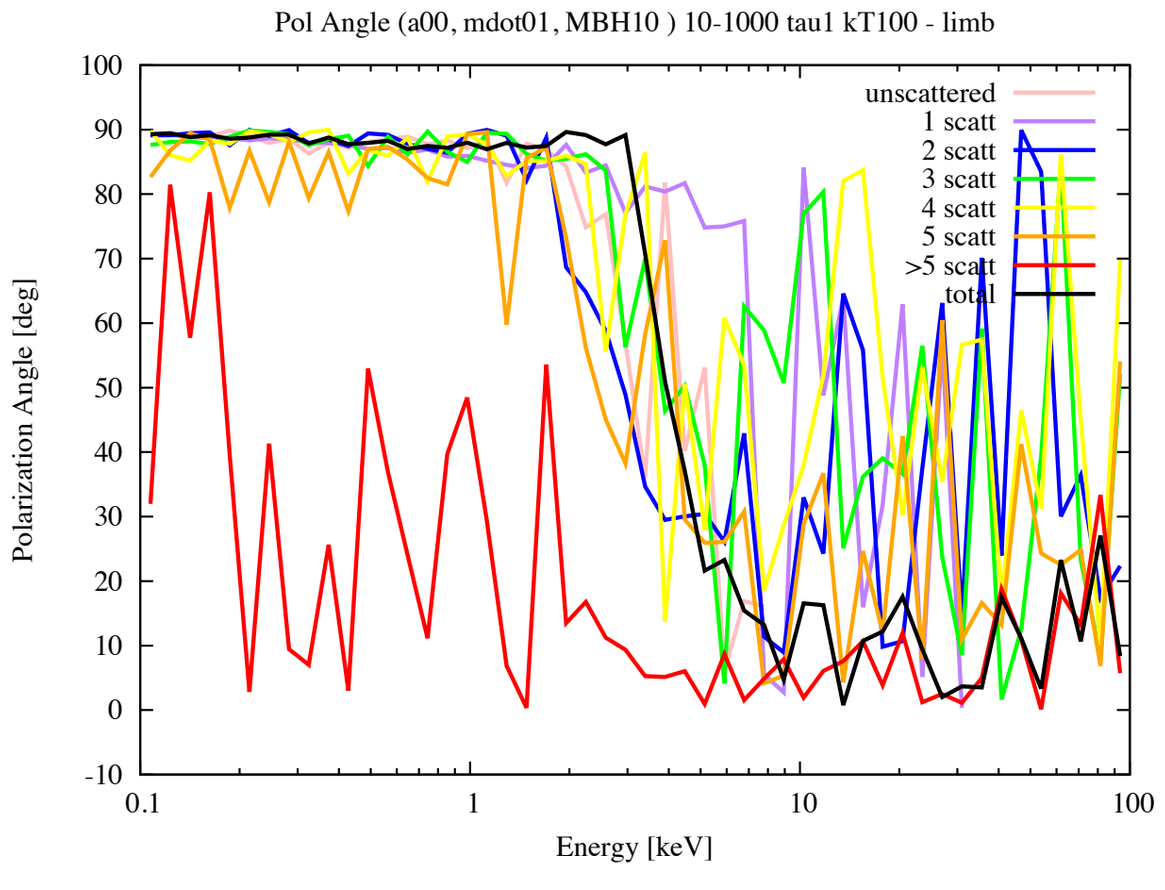
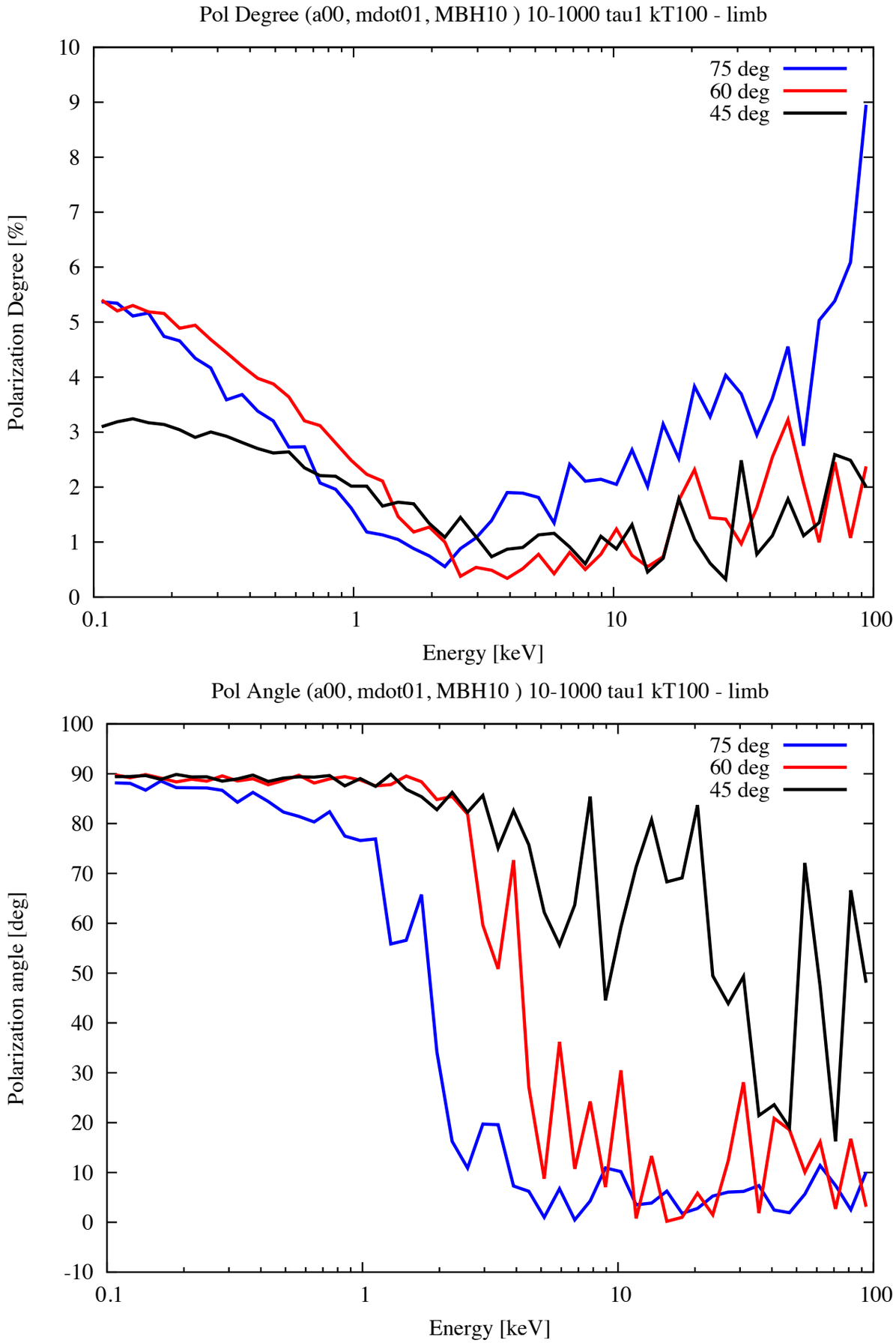




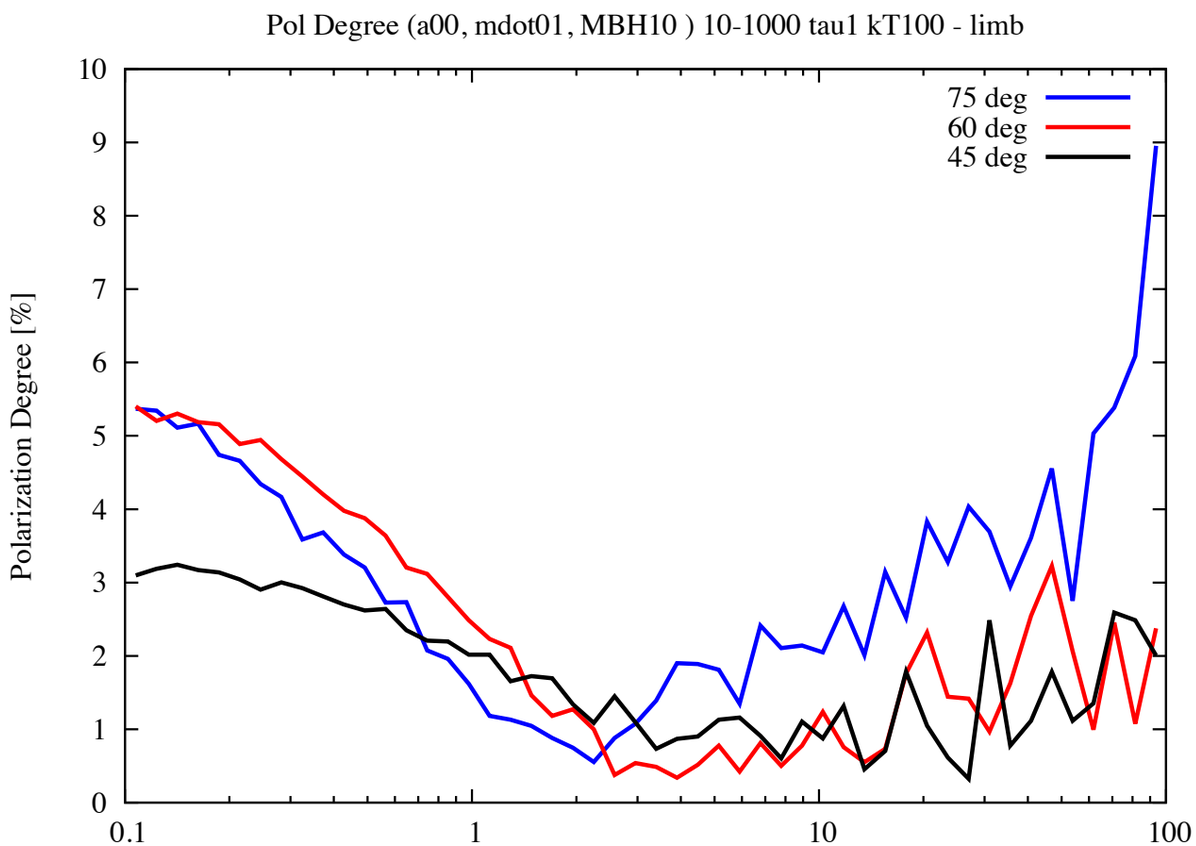


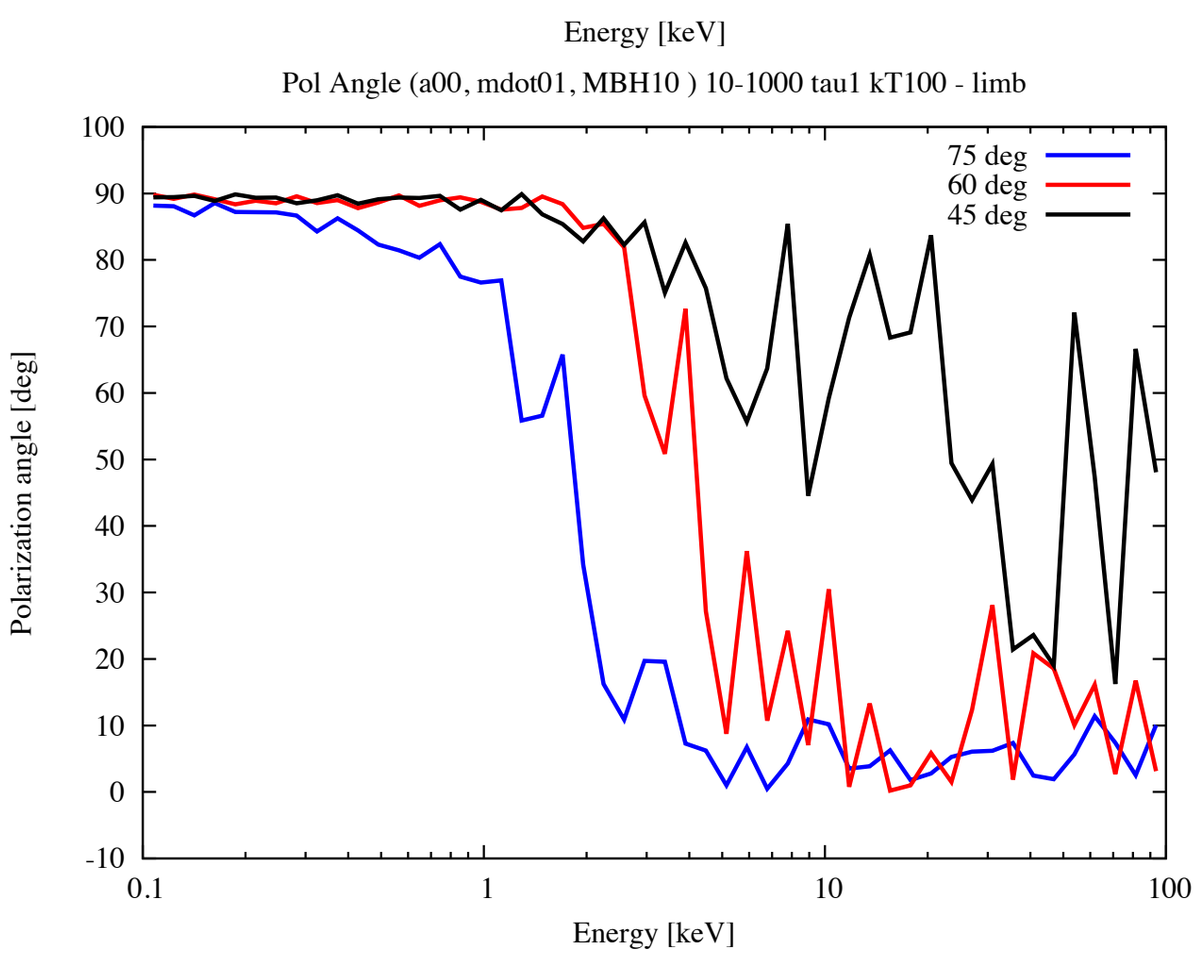


a0 limb / SLAB tau1

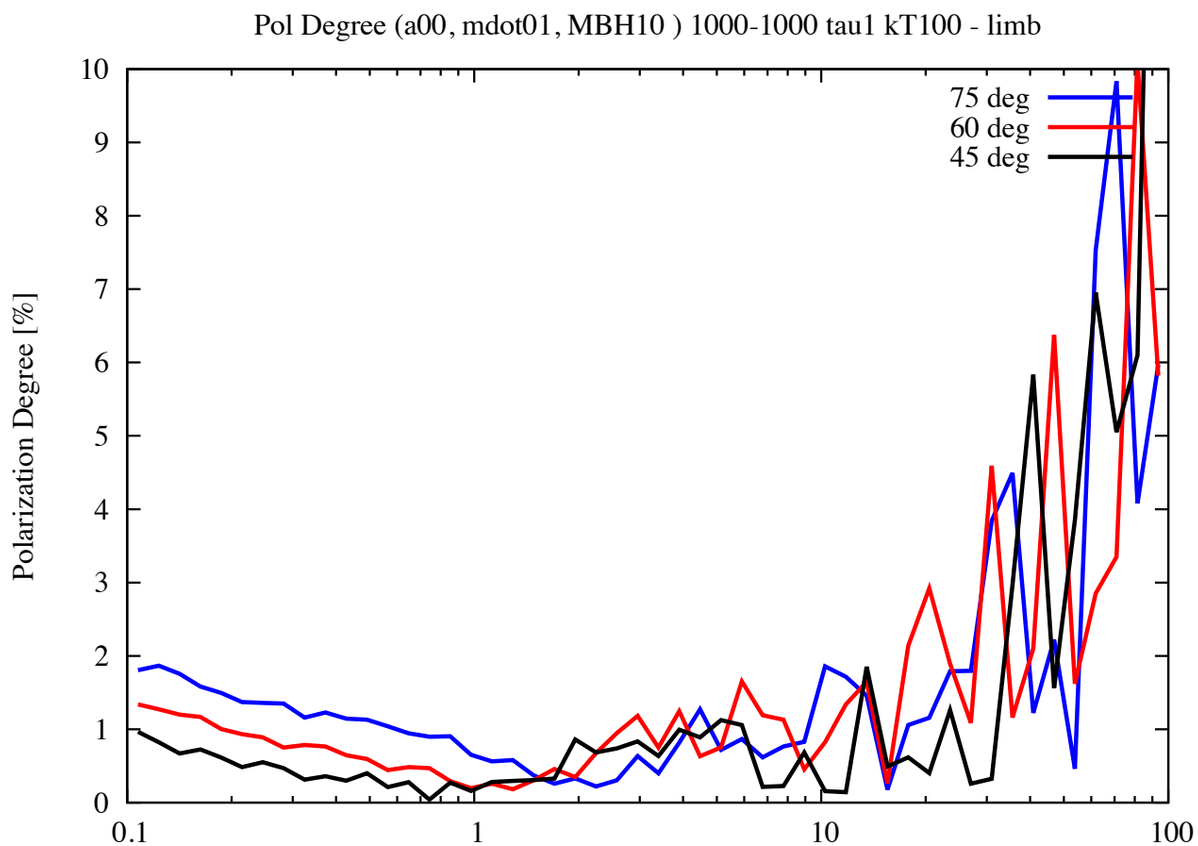


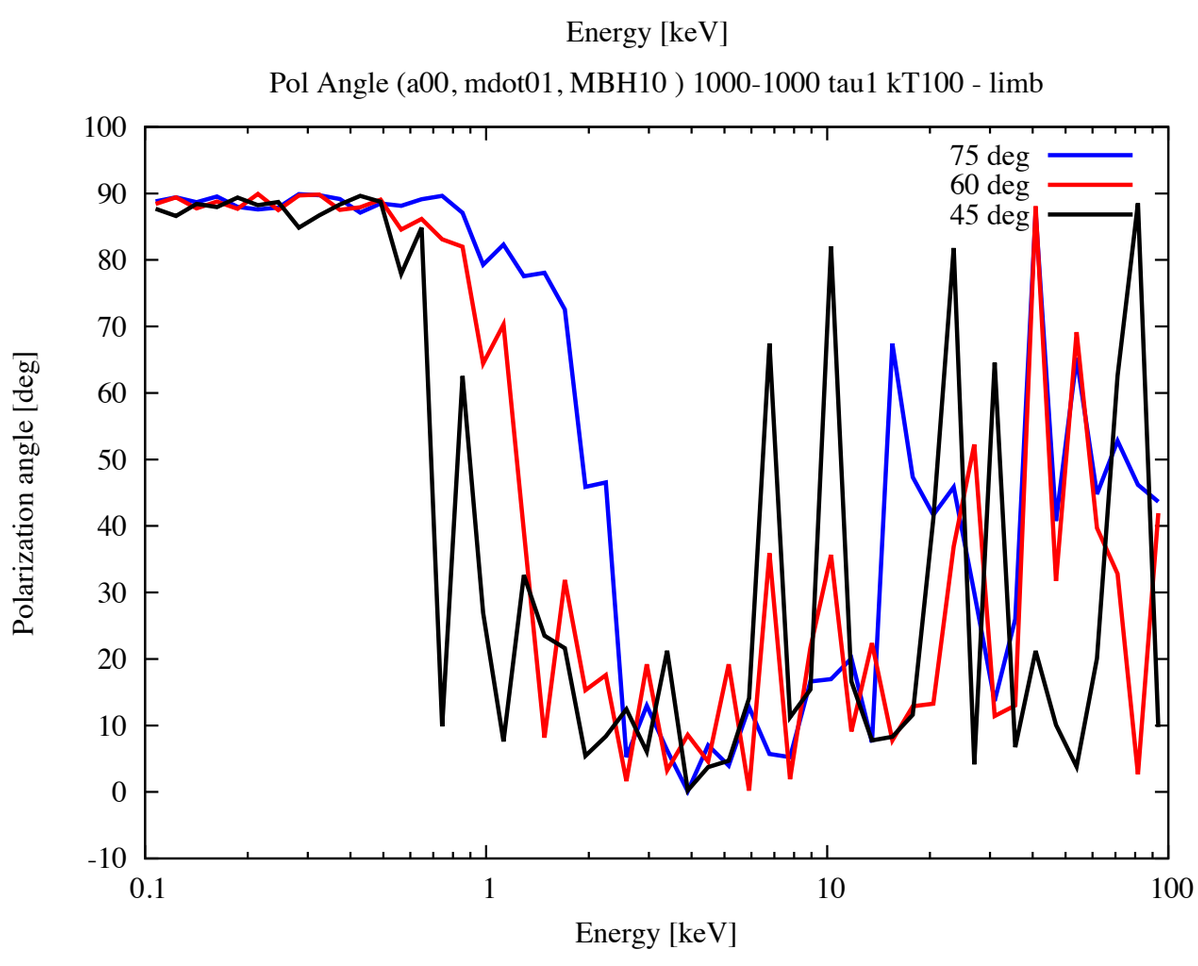
a0 limb / SLAB tau1



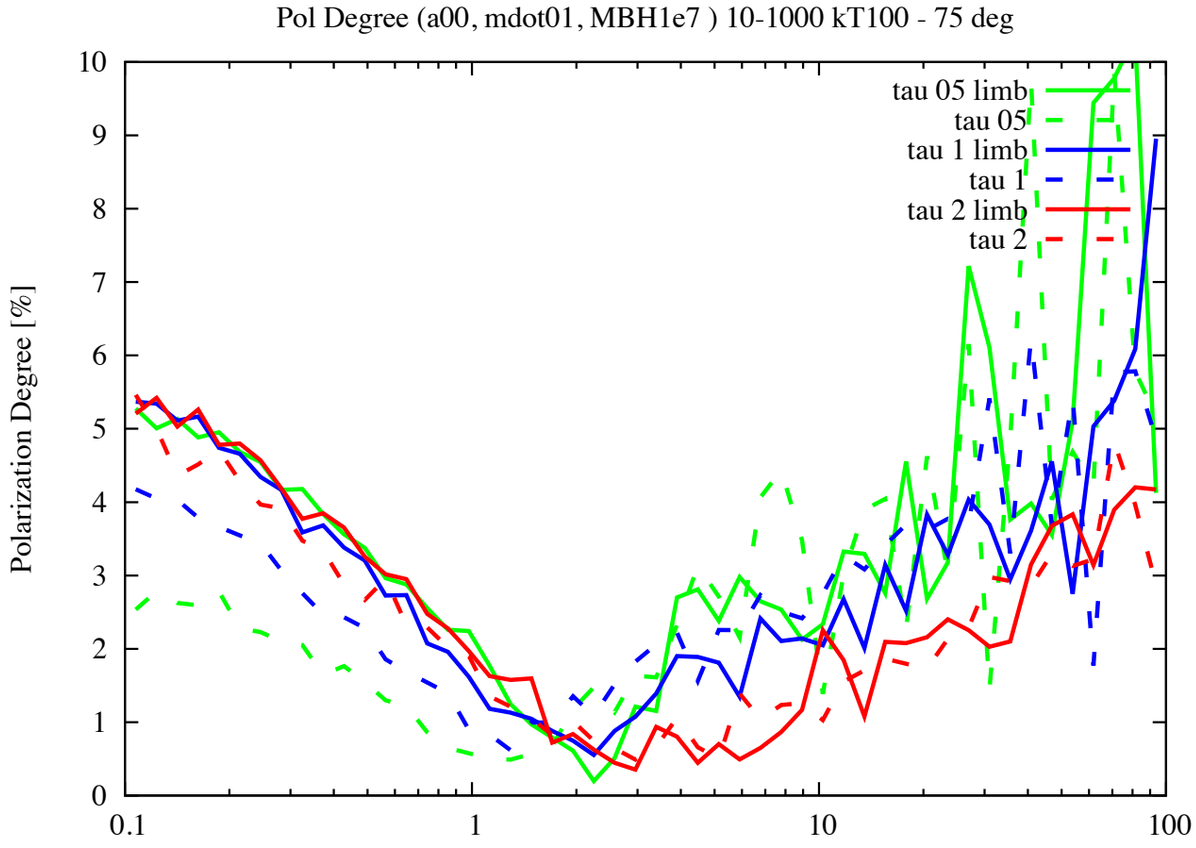


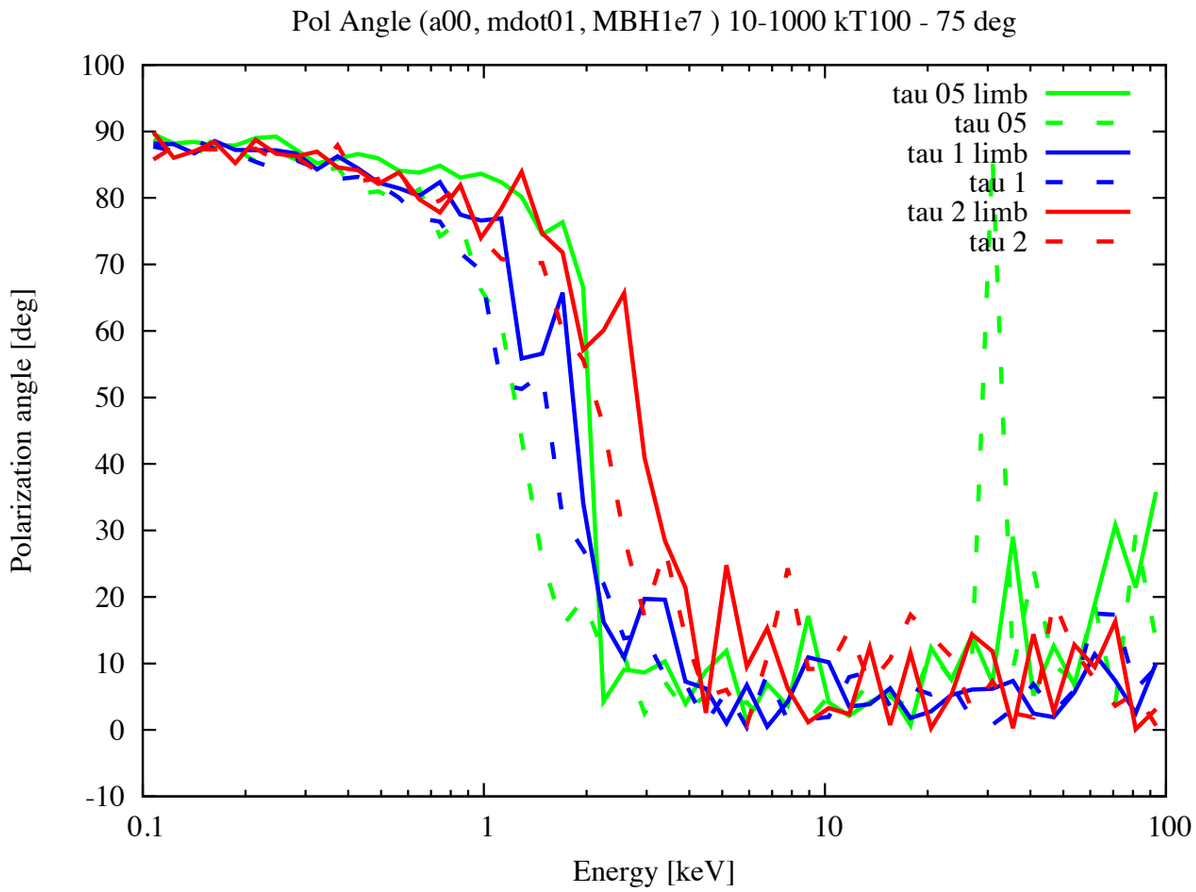
a0 limb / SPHERE tau1



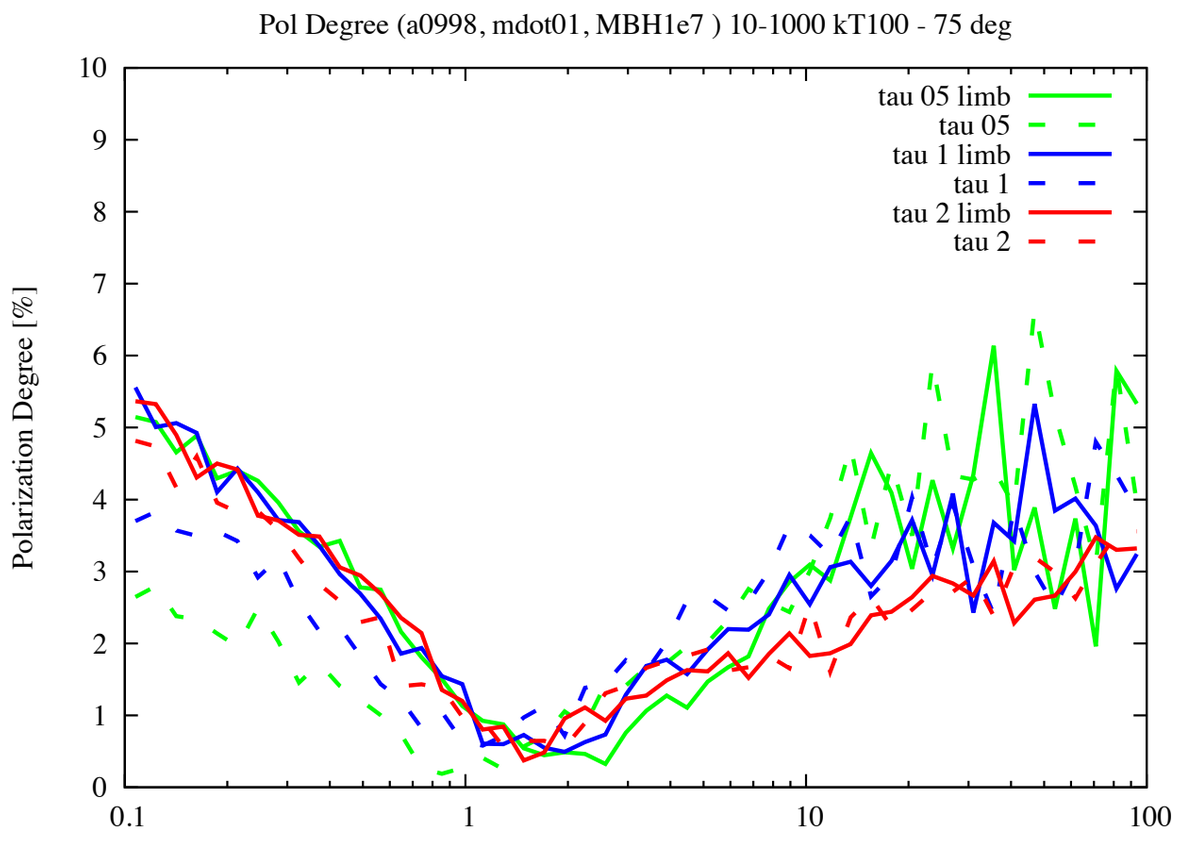


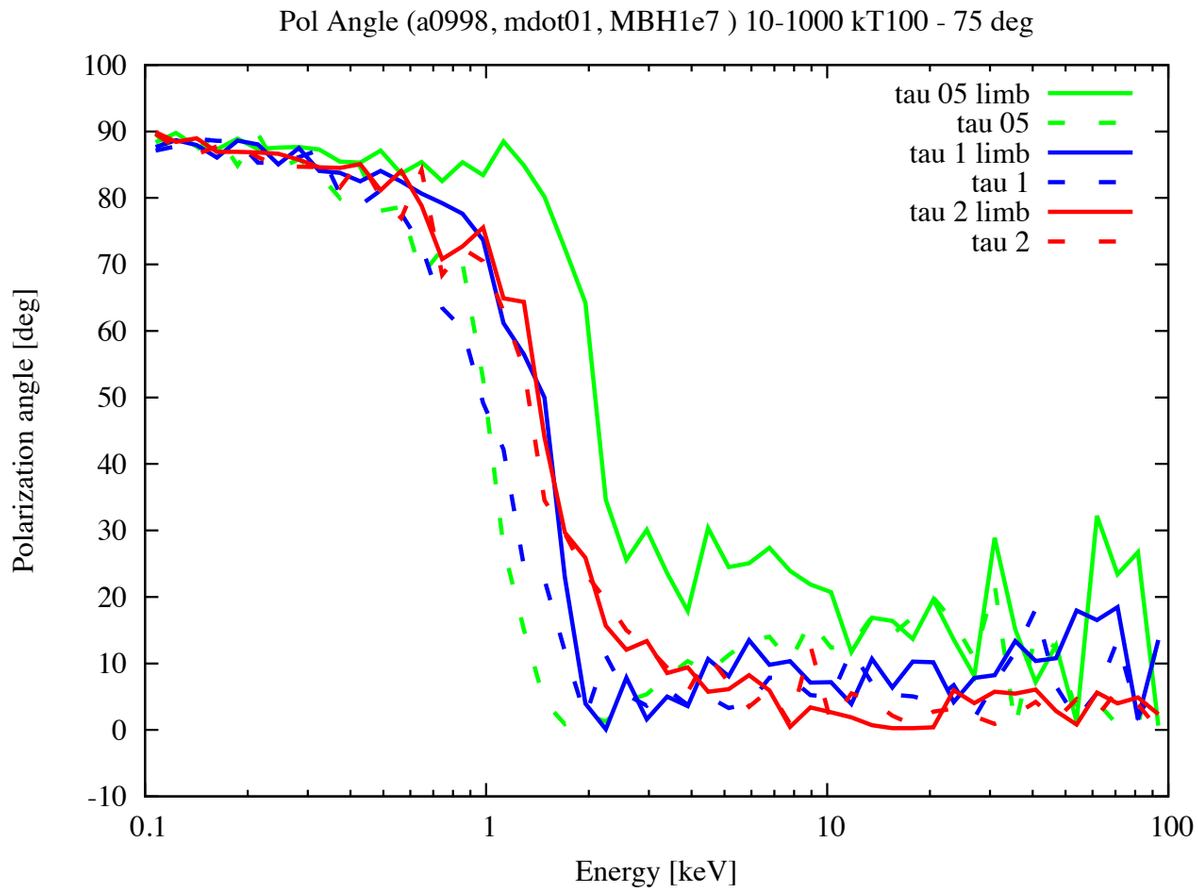
SLAB a0 – tau 05/1/2 – limb ON/OFF



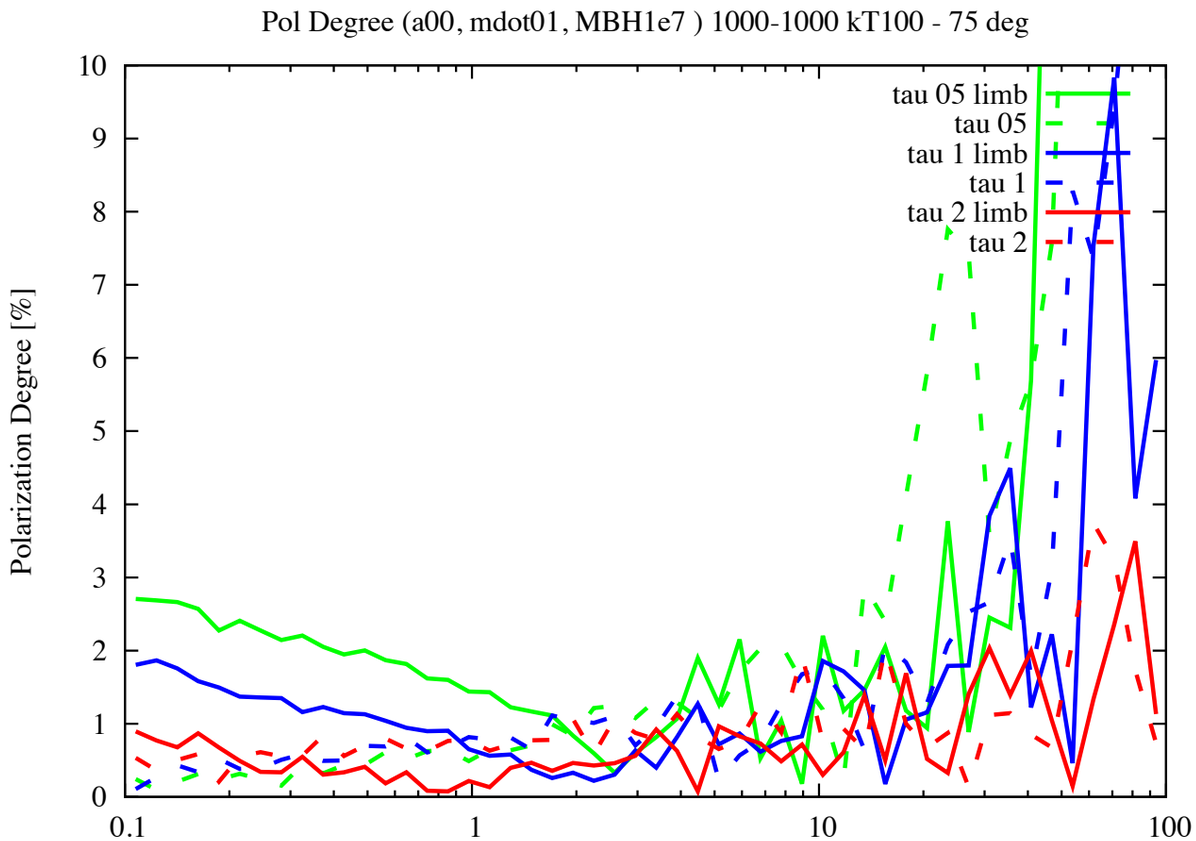


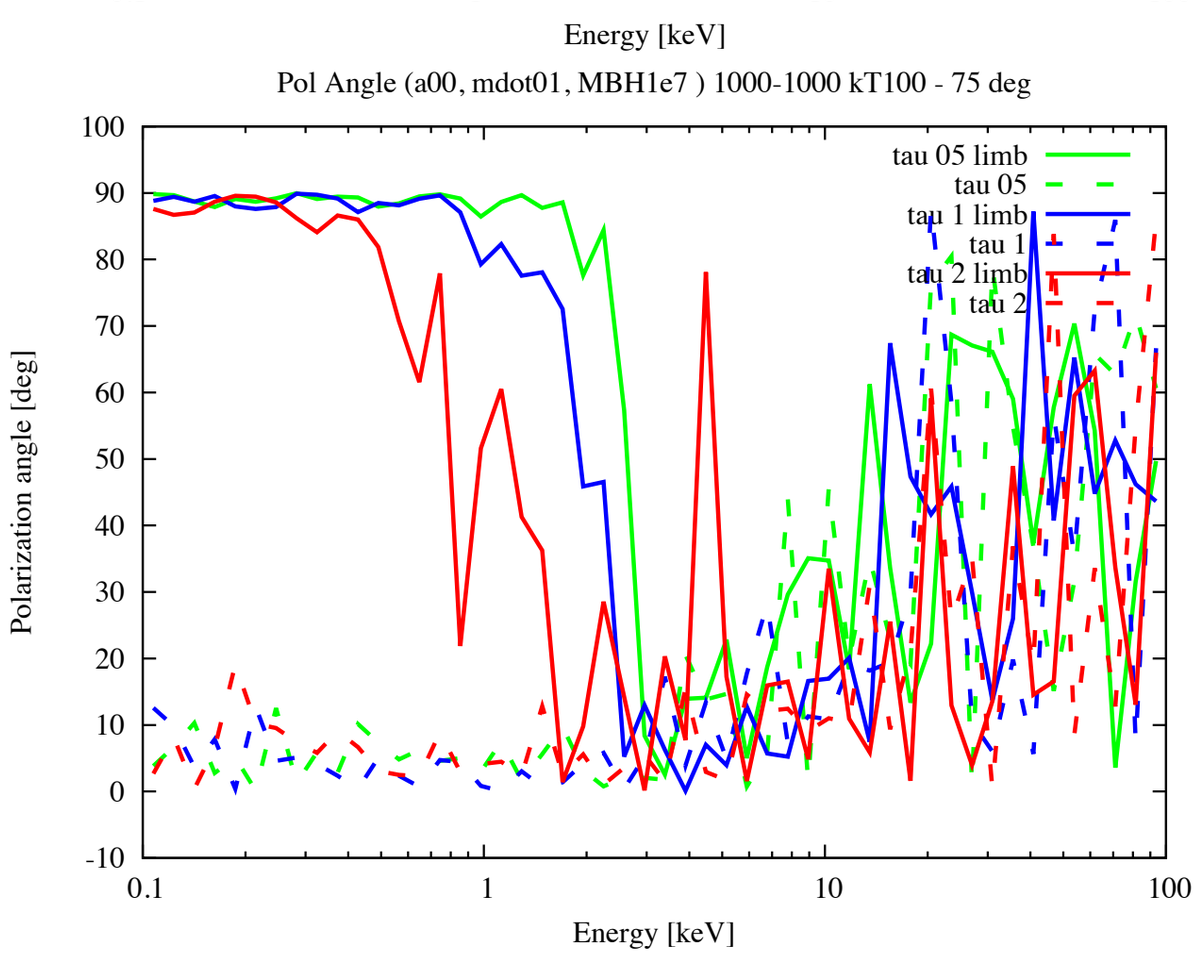
SLAB a0998 – tau 05/1/2 – limb ON/OFF



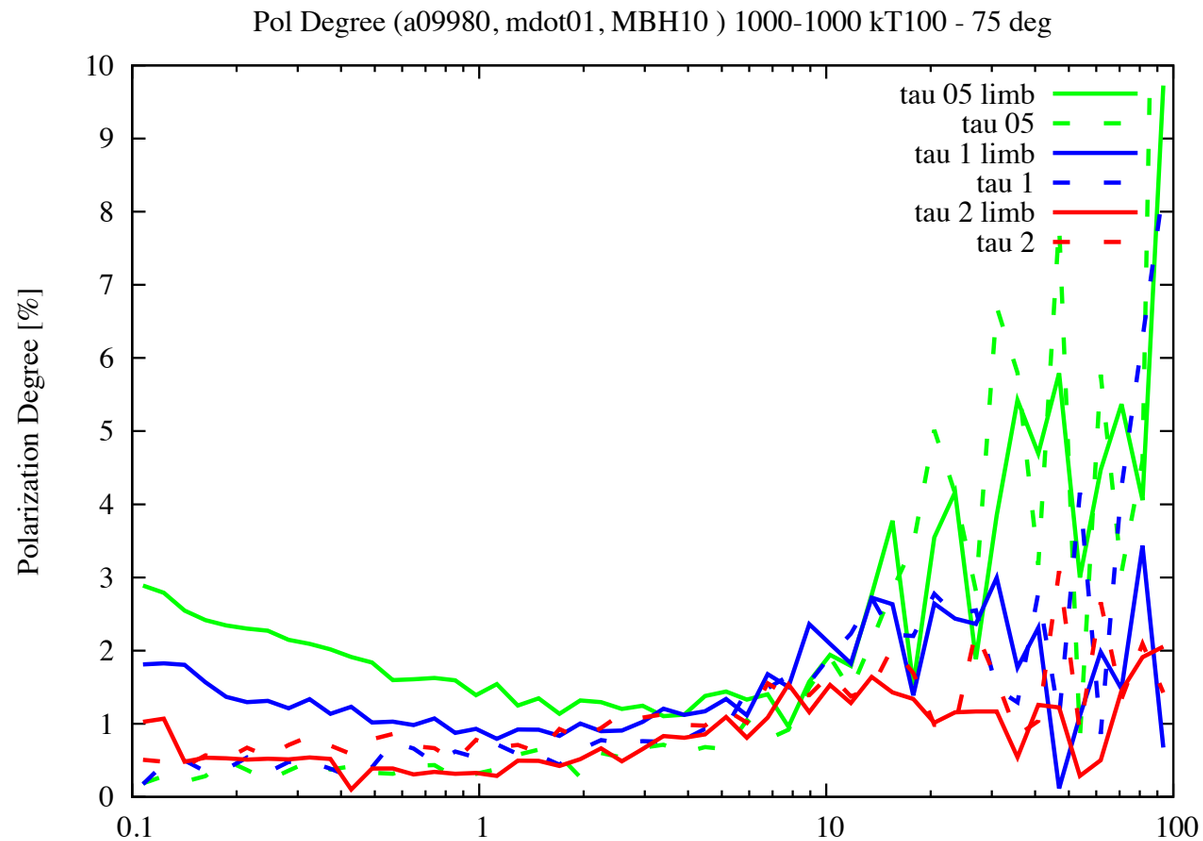


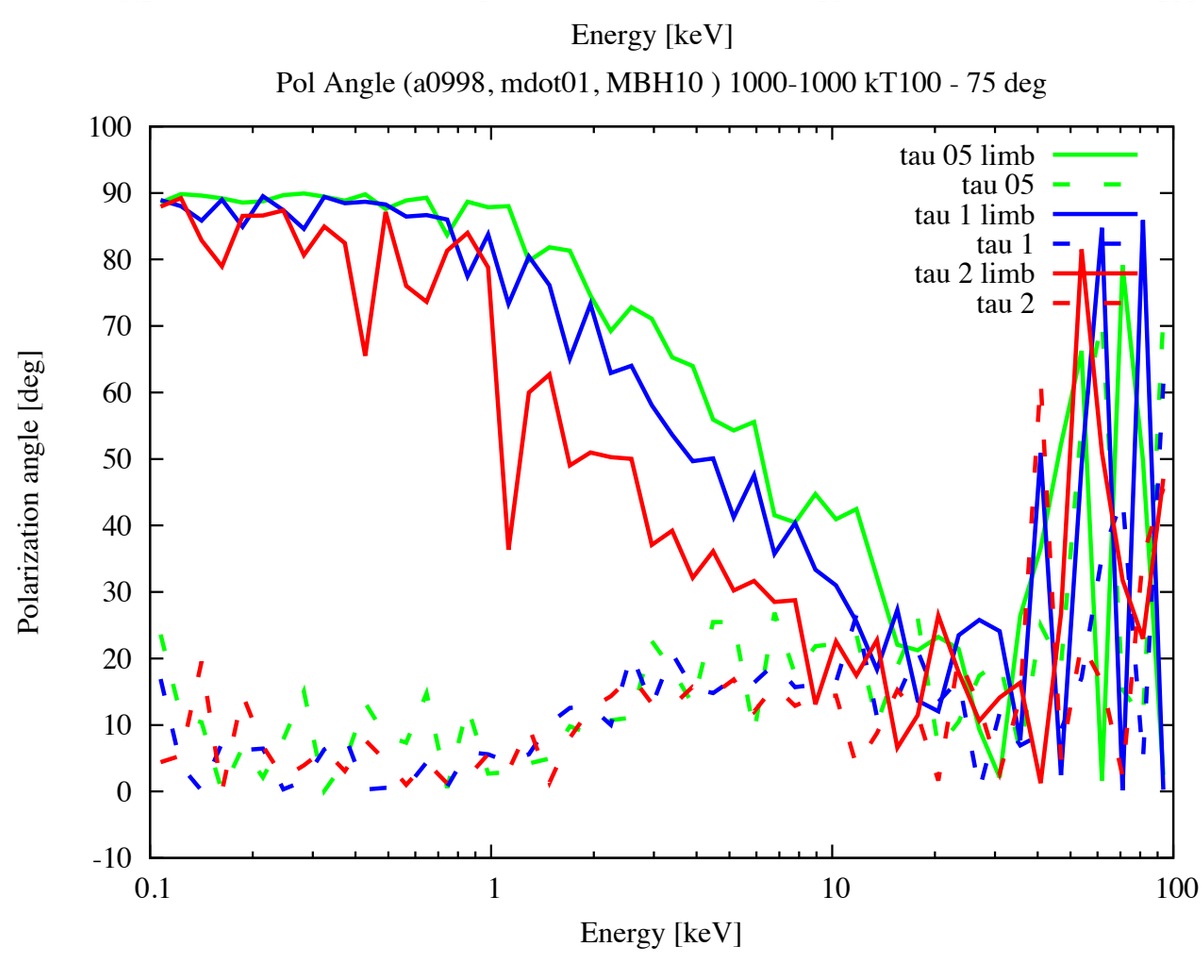
SPHERE a0 – tau 05/1/2 – limb ON/OFF





SPHERE a0998 – tau 05/1/2 – limb ON/OFF

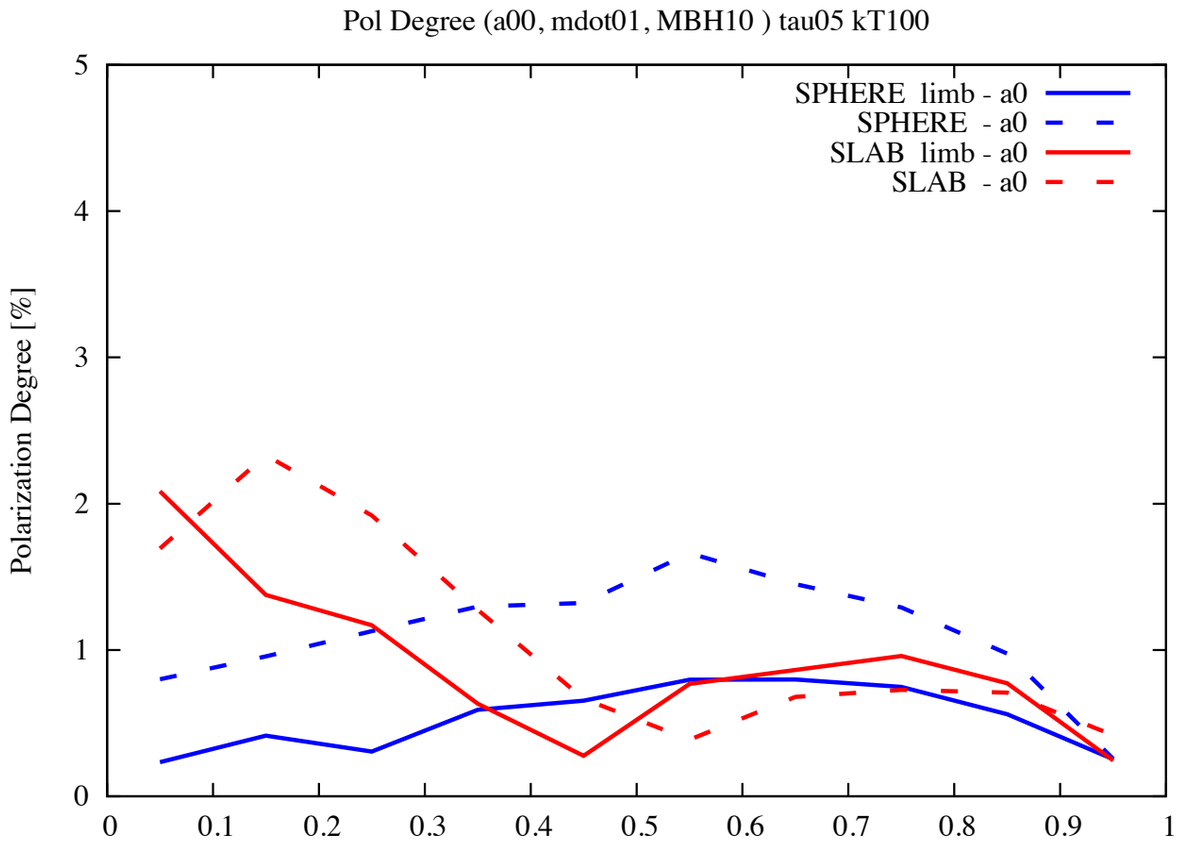


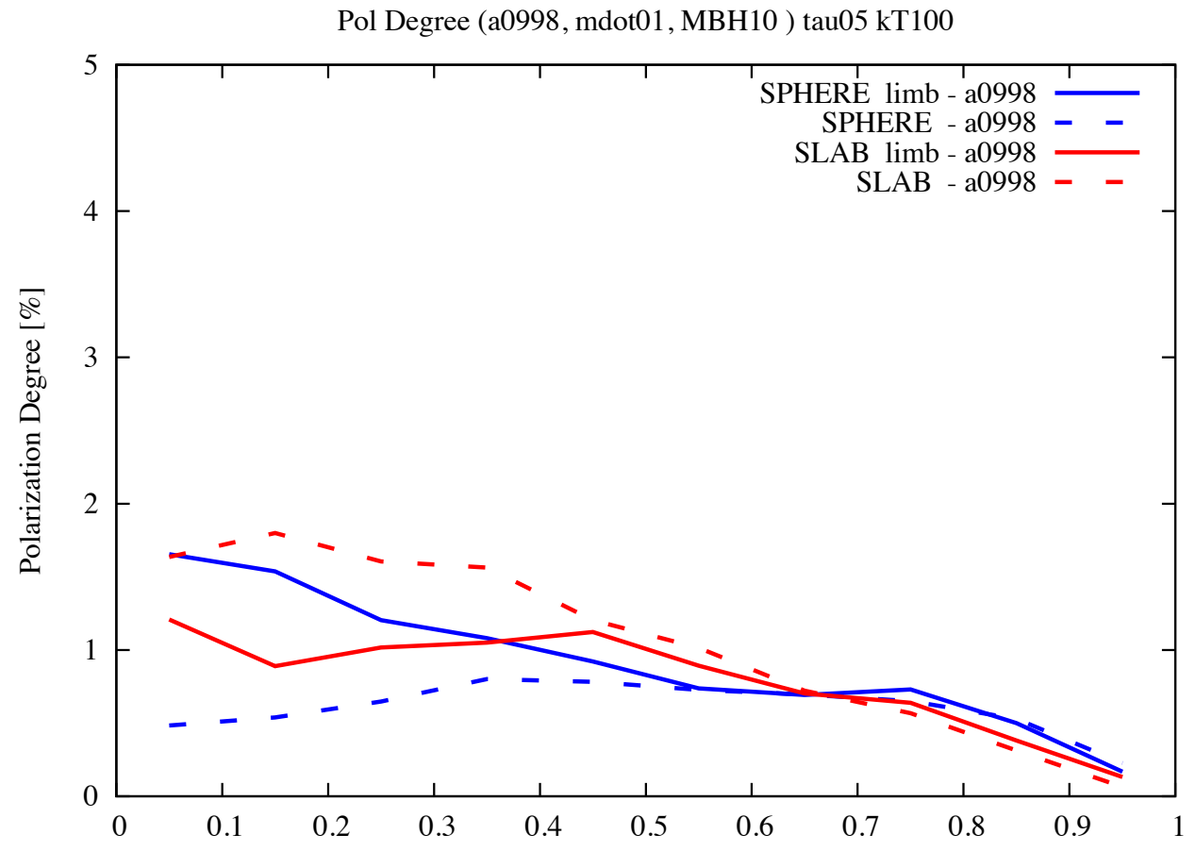


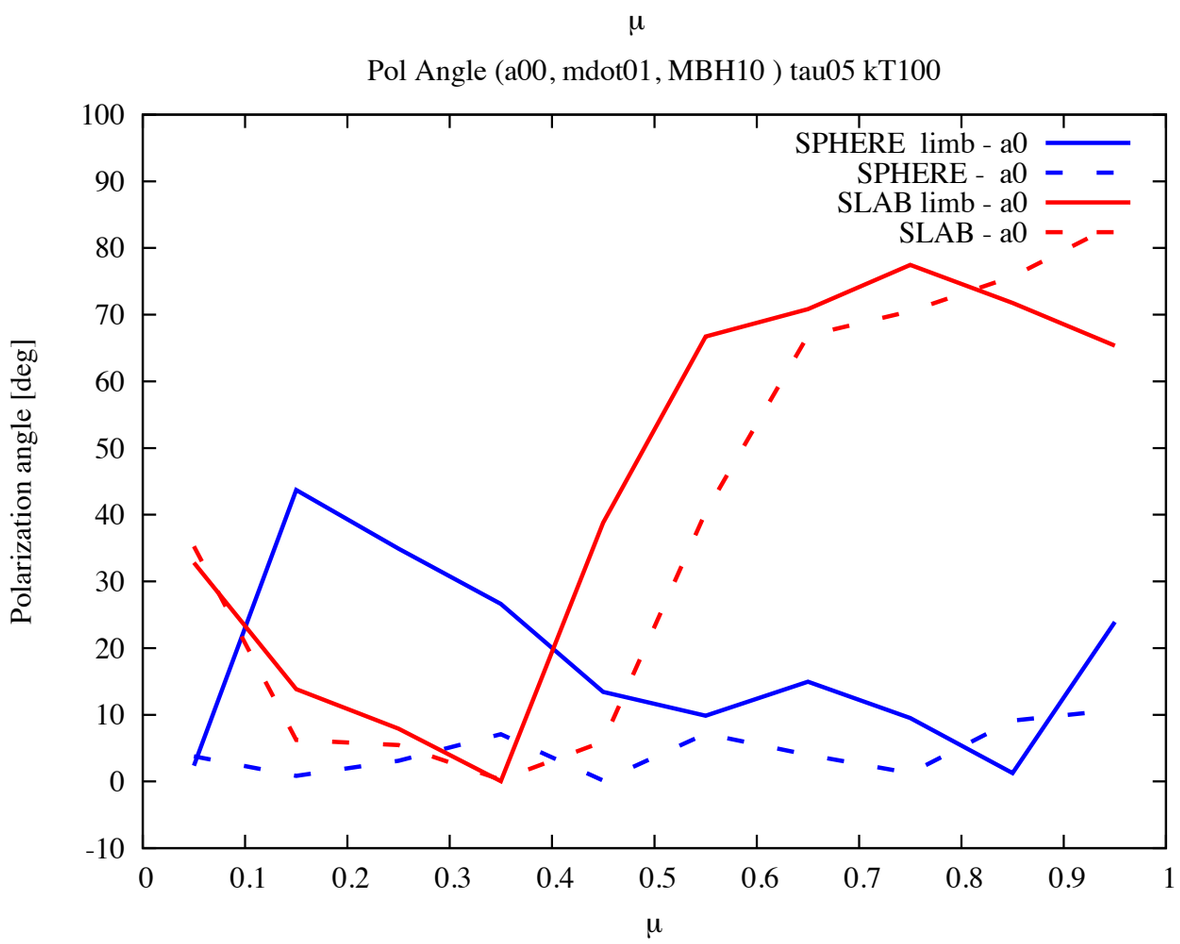
a0

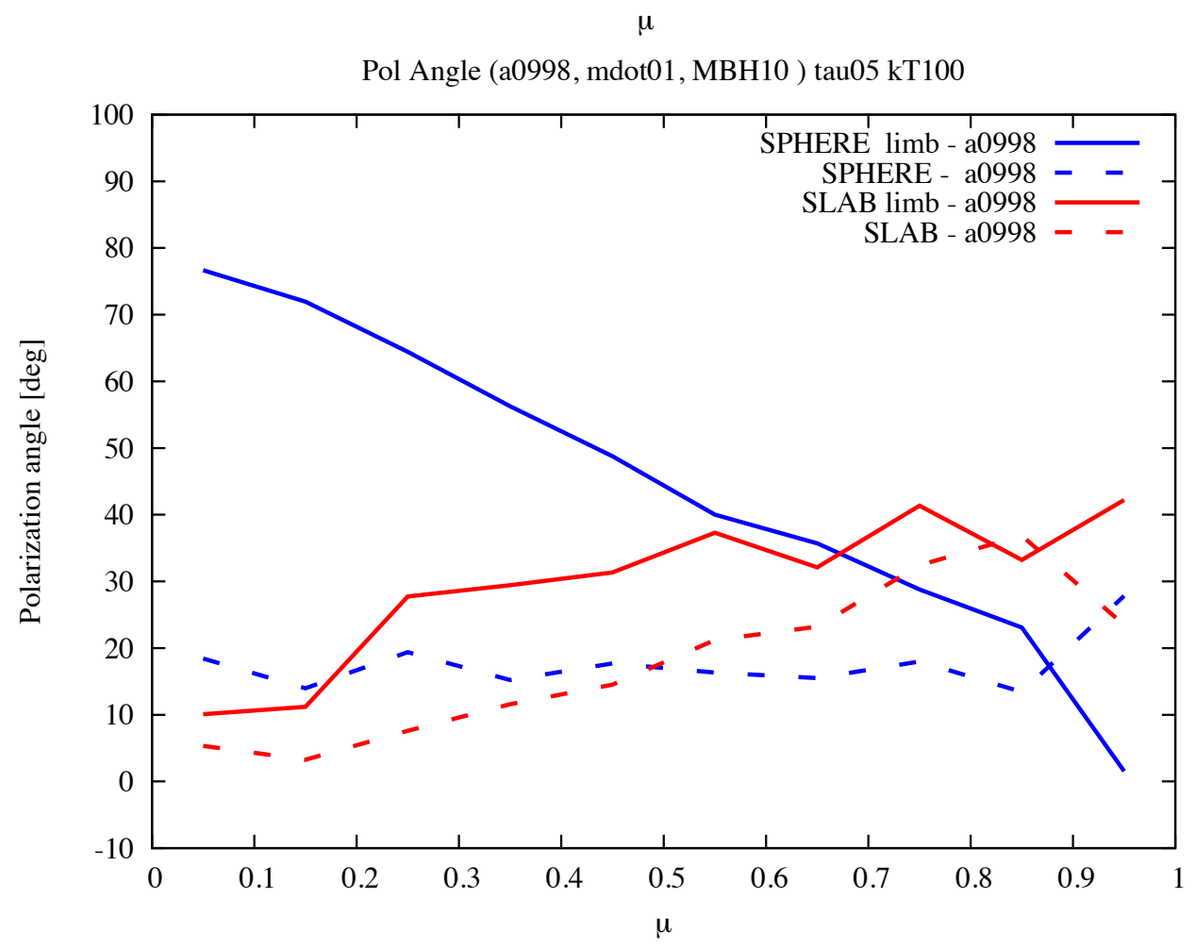
tau 05

a0998









a0

tau 1

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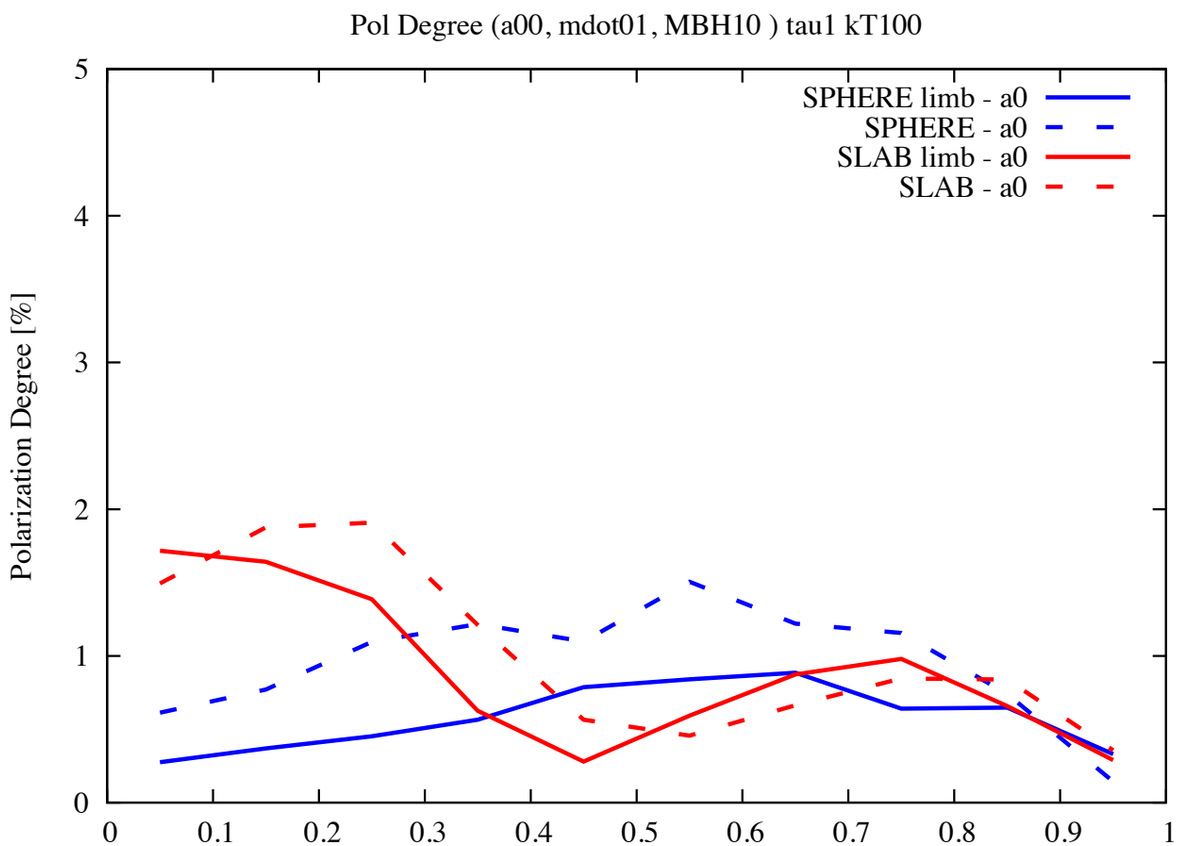

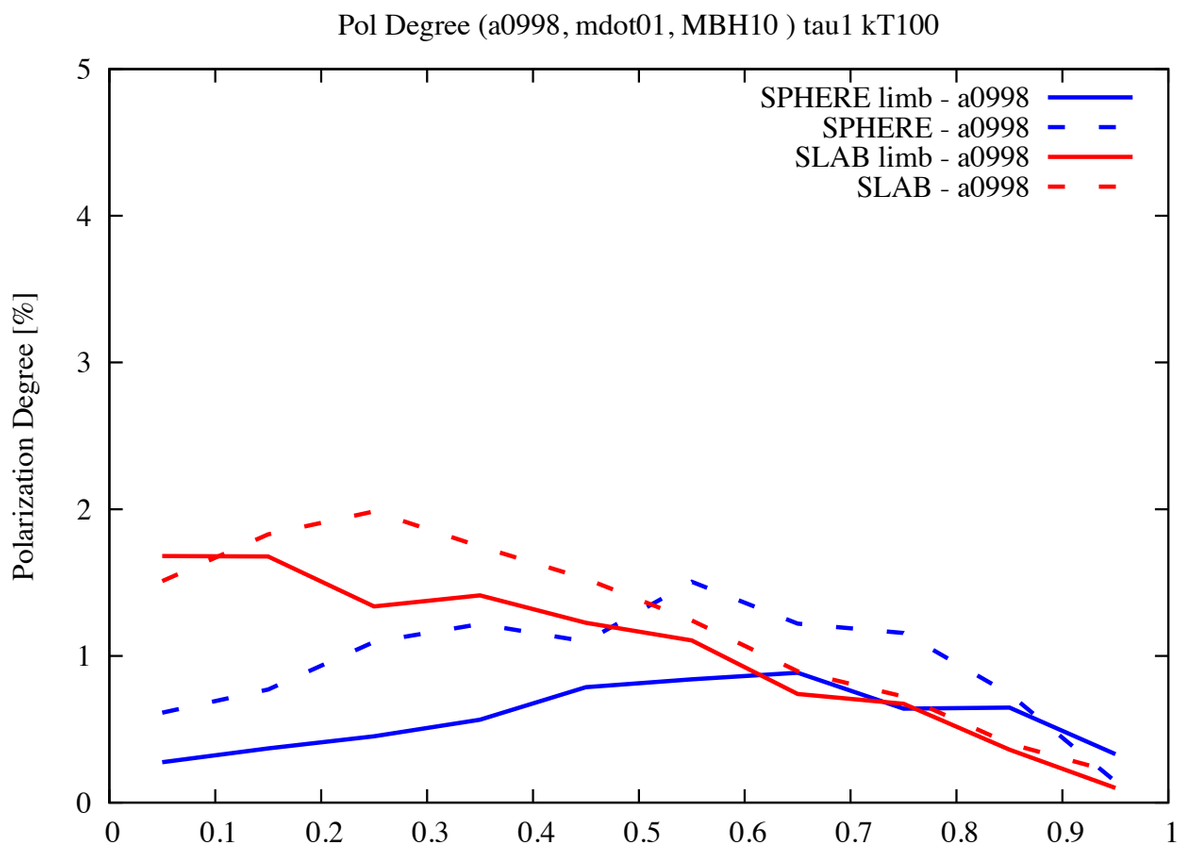

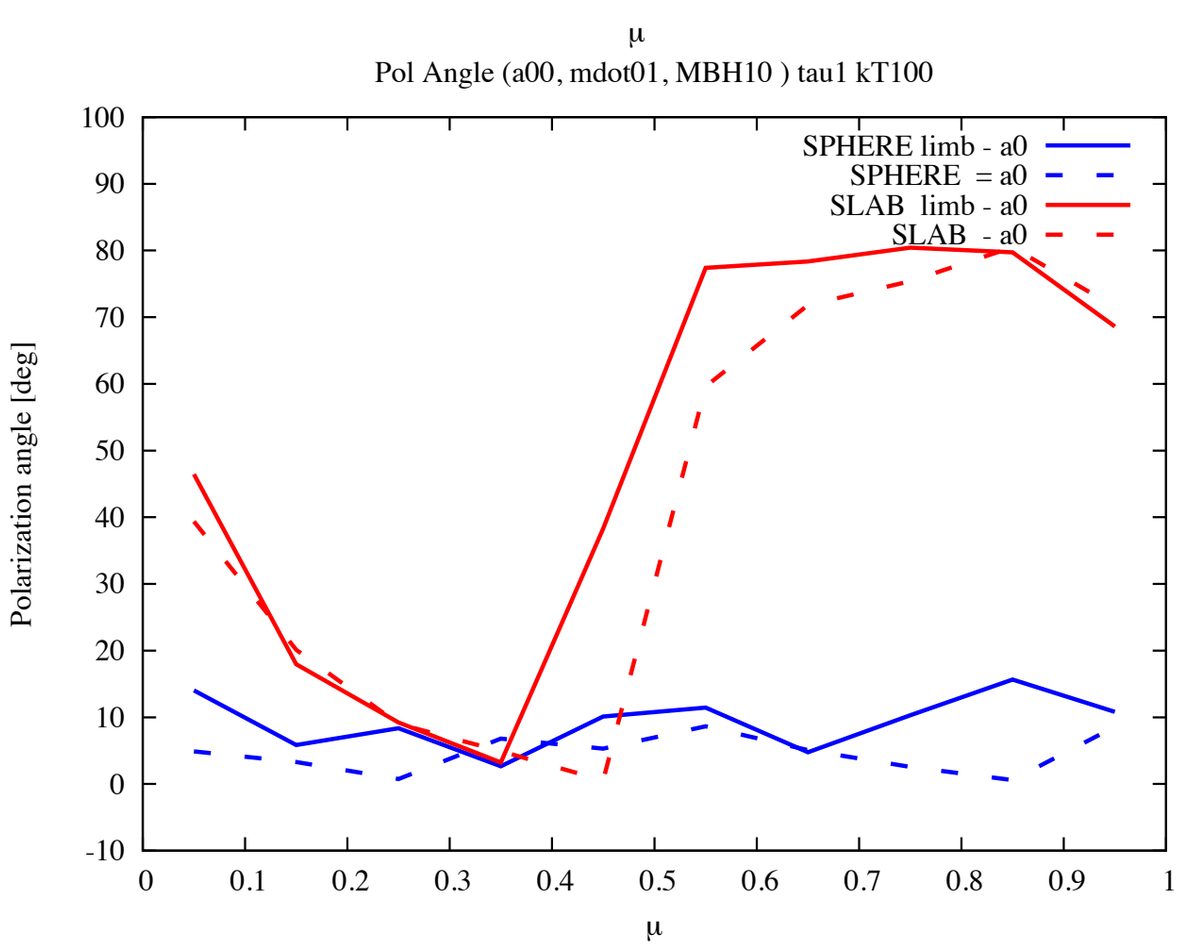

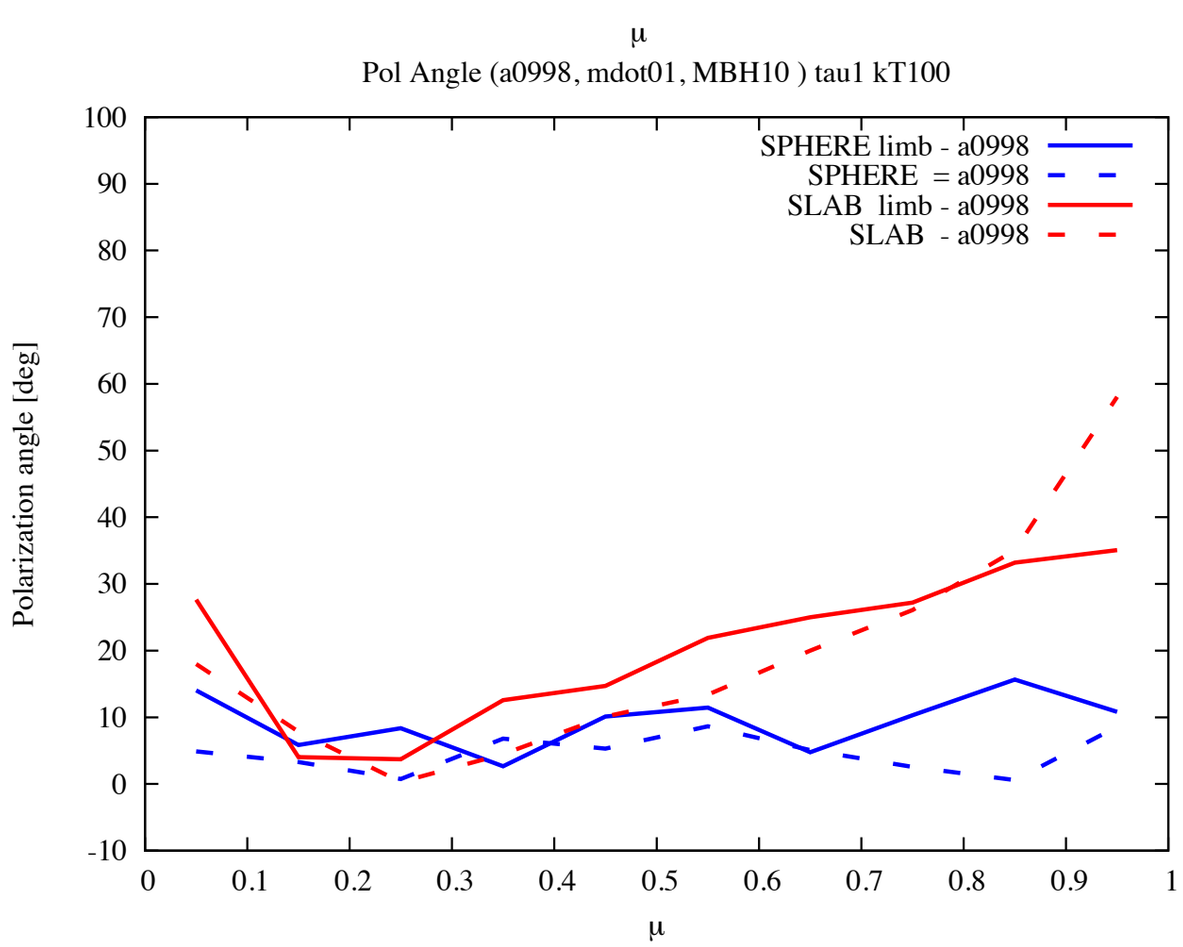

a0

tau 2

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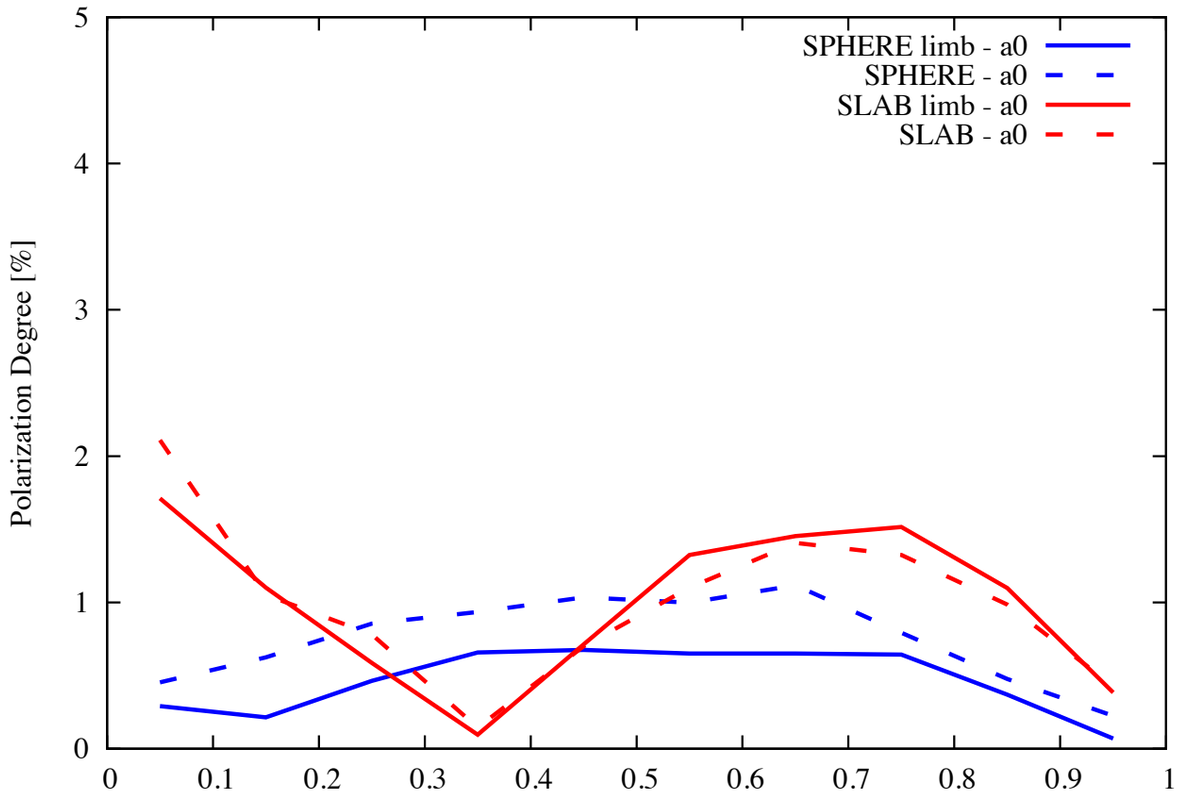

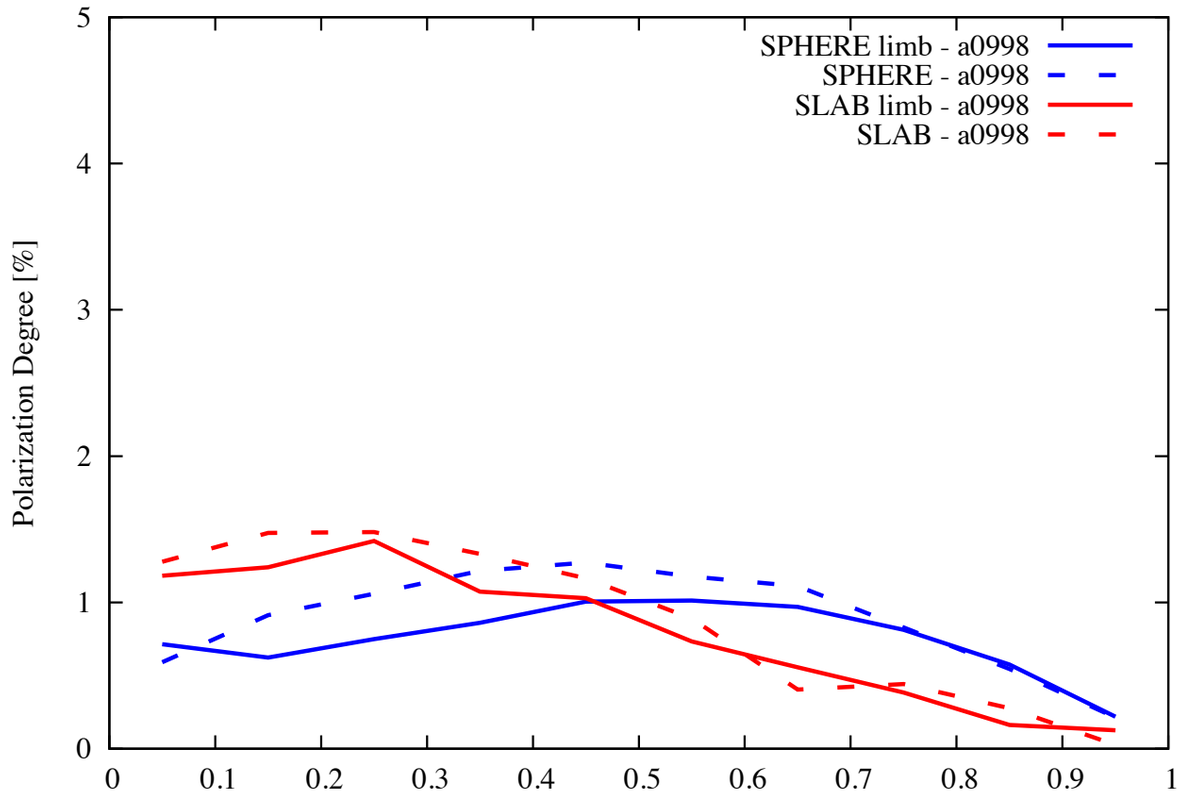

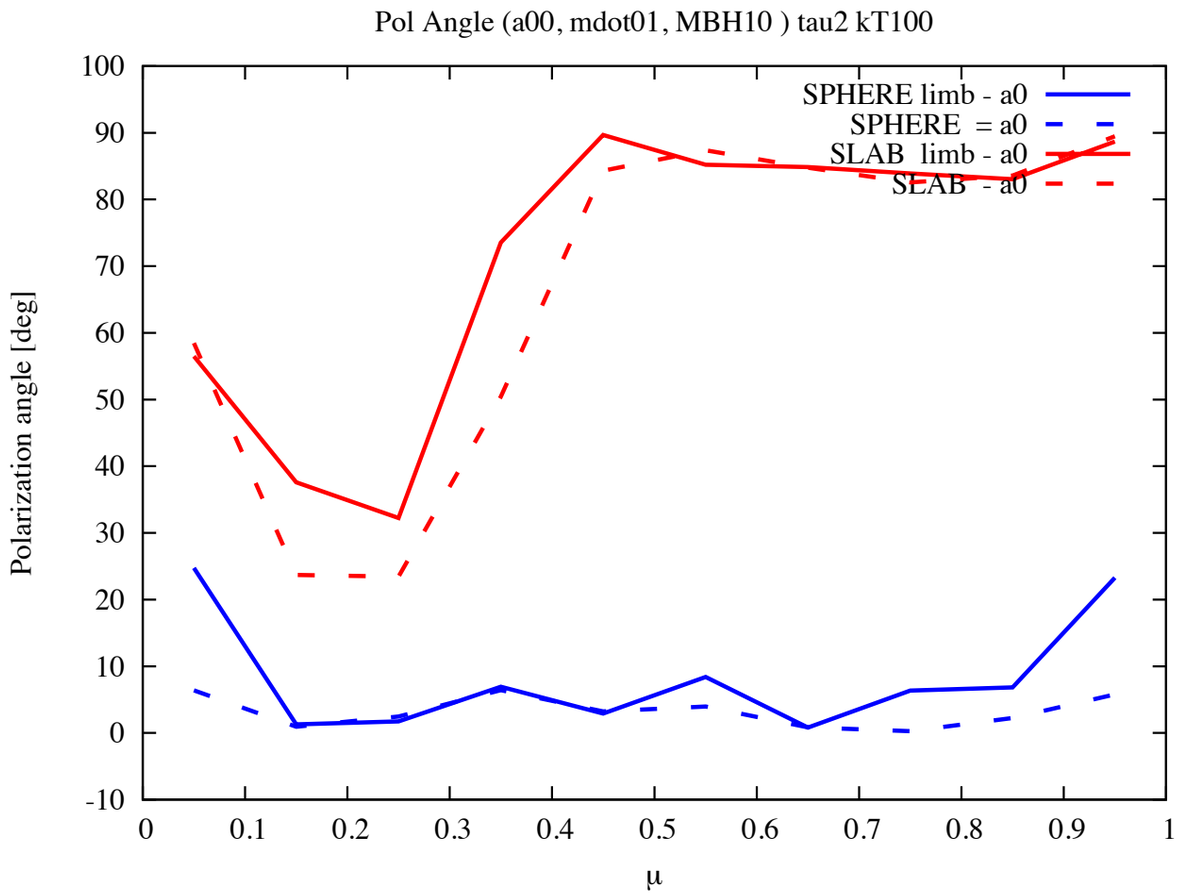

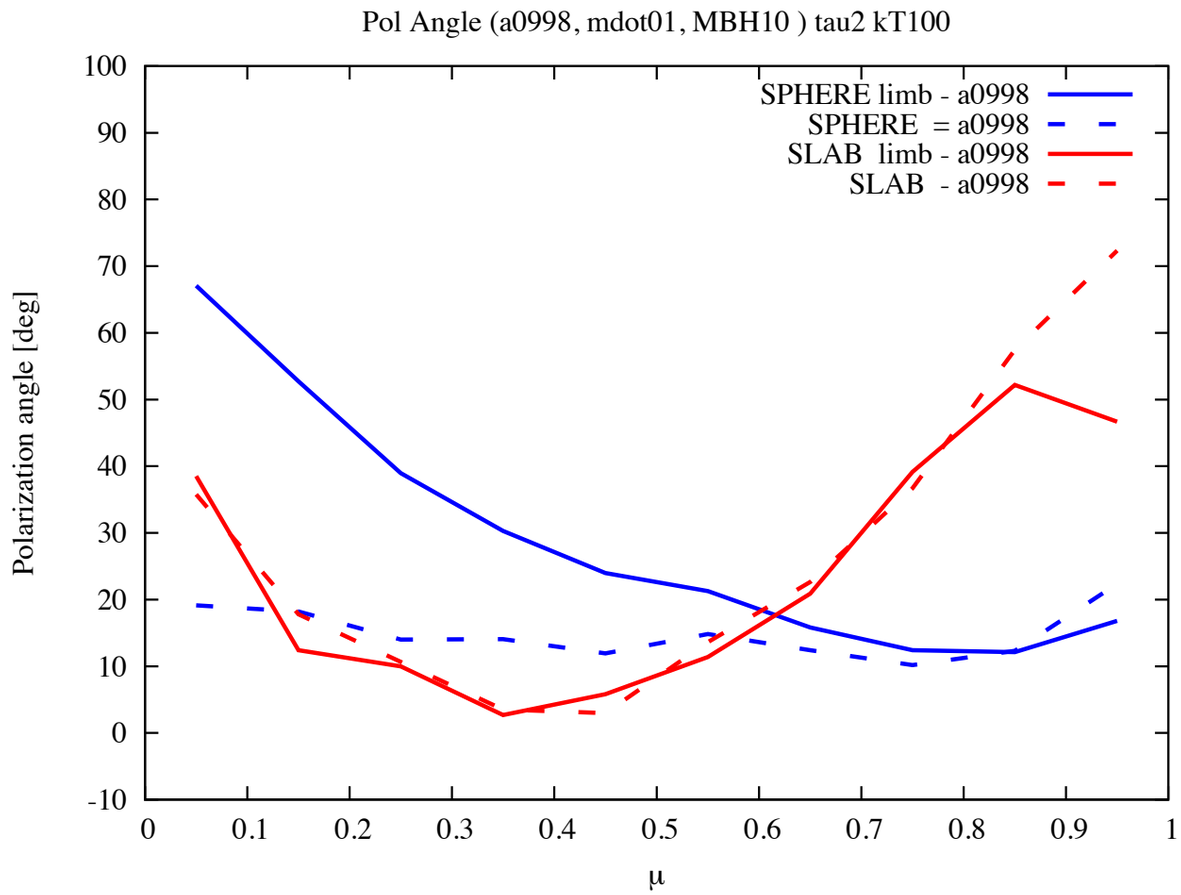

Conclusions & Future Developments

X-ray polarization has the potential to discriminate (certain) geometries even w/o exploiting the spectral capabilities of future polarimeters (IXPE, eXTP)

If the data will be in very high quality it has the potential to even constrain the spin of the BH

While waiting for 2021…

- Develop more realistic models (i.e. compact corona) and explore all the parameters space
- Apply MoCA to different interesting astrophysical case of study (e.g. GRB)
- Investigate the impact of polarization on corona/disc feedback (partially underway)