

ON THE POLARISATION SIGNAL PRODUCED BY COMPTONIZATION IN ACCRETING SOURCES

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OUTLINE

- Scientific motivation
- MoCA in a nutshell
- The polarisation signal representation
- Polarisation signal in AGN
- Polarisation signal in BHs
- Conclusions

SCIENTIFIC MOTIVATION

We can safely say that at least 90% of astronomy is made using photons.
However in X-ray we only use 2 observables out of three:

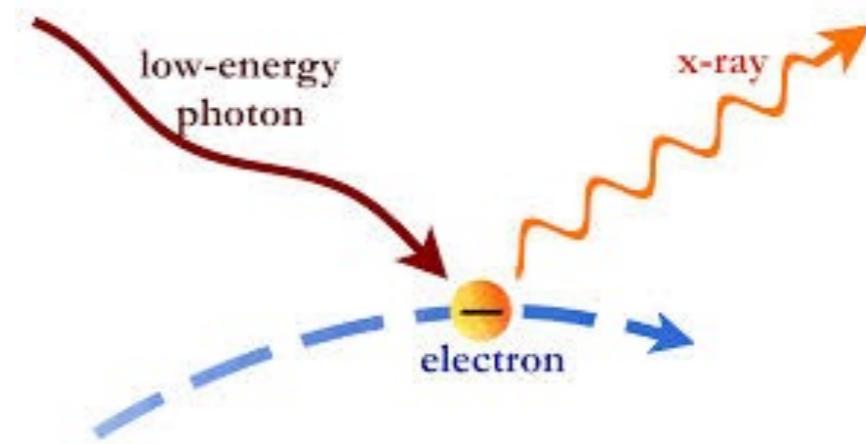
energy (spectral analysis)
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The X-ray spectrum observed in accreting sources is believed to be produced by Comptonization of soft photons coming from the disc by an hot corona of electrons whose geometry is still unknown.

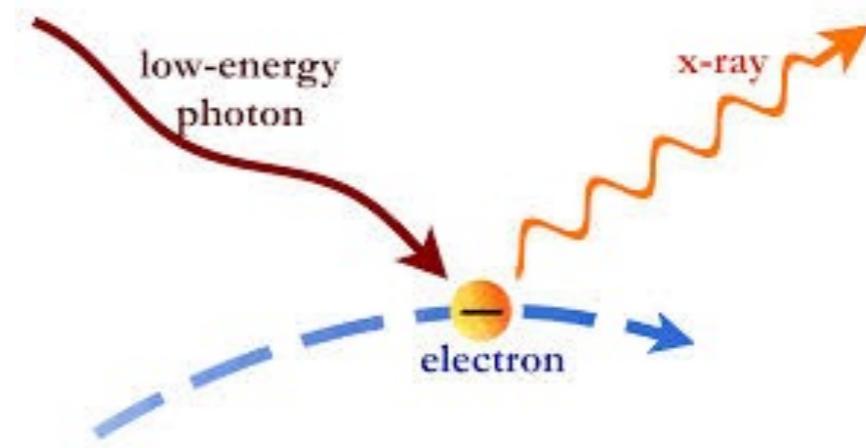


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Inverse Compton, as any scattering process, should produce radiation linearly polarised perpendicularly to the plane of scattering, reflecting the geometry of the scattering material.

The polarisation signal will be stronger as the material is more asymmetric and/or as it is seen from a line of sight maximising its asymmetry.

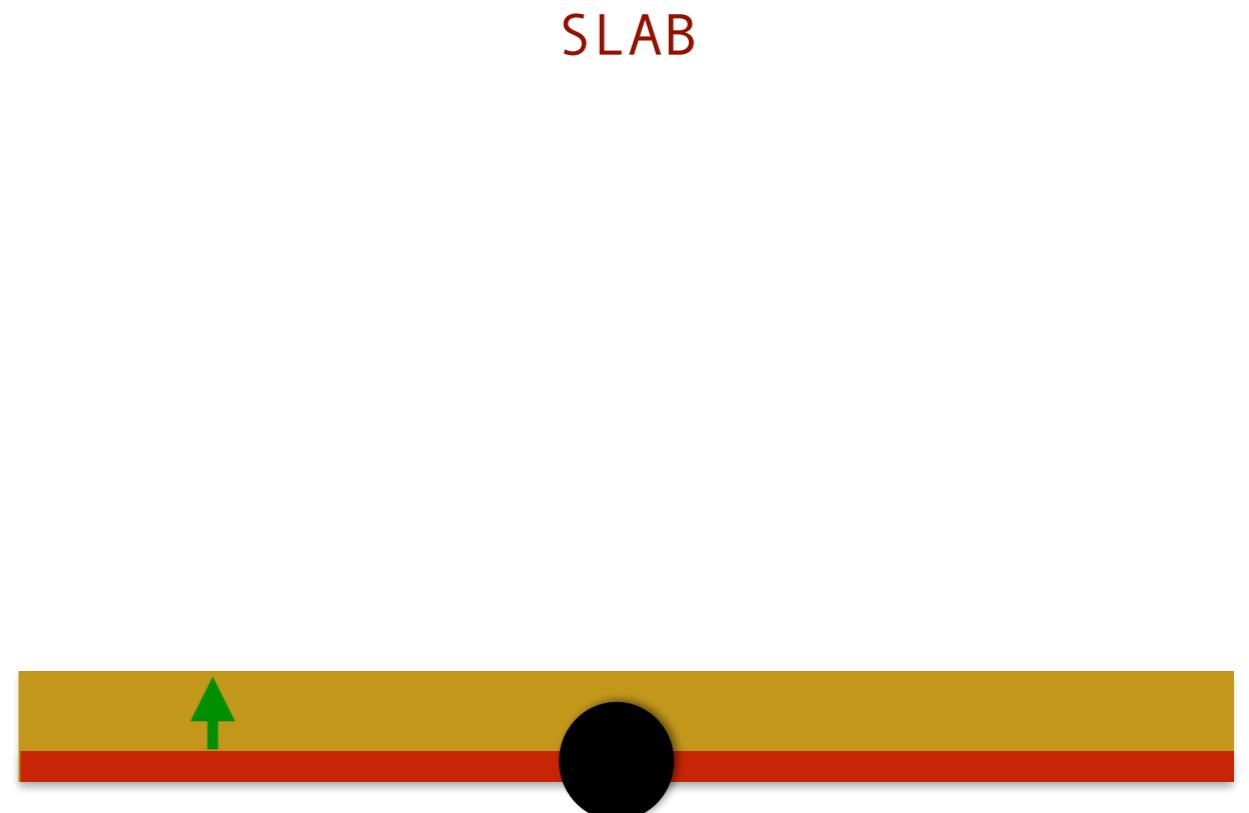
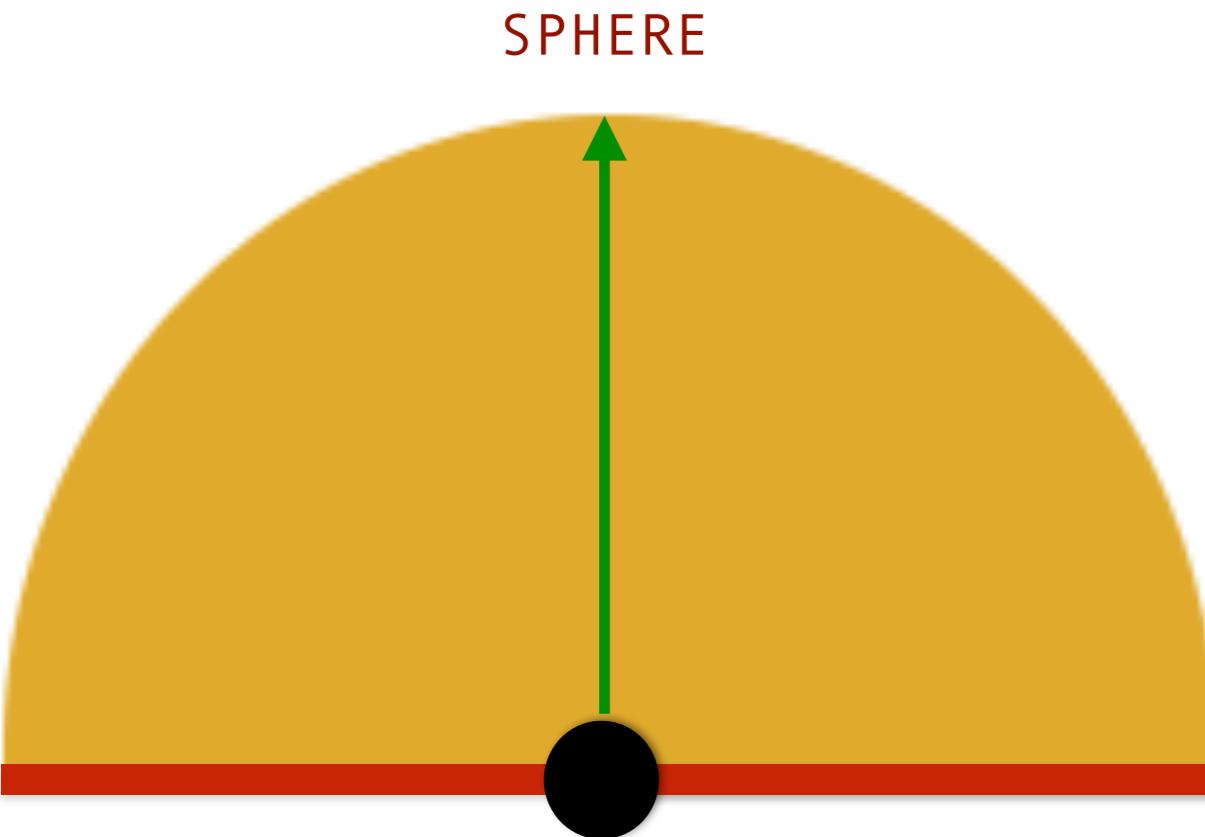
X-ray polarisation analysis, together with spectroscopical analysis, has the potential to constrain the inclination of the system and the geometry of the corona

MOCA IN A NUTSHELL

For these reasons we developed MoCA: a Monte Carlo code for Comptonization in Astrophysics
(Tamborra et al. in prep.)

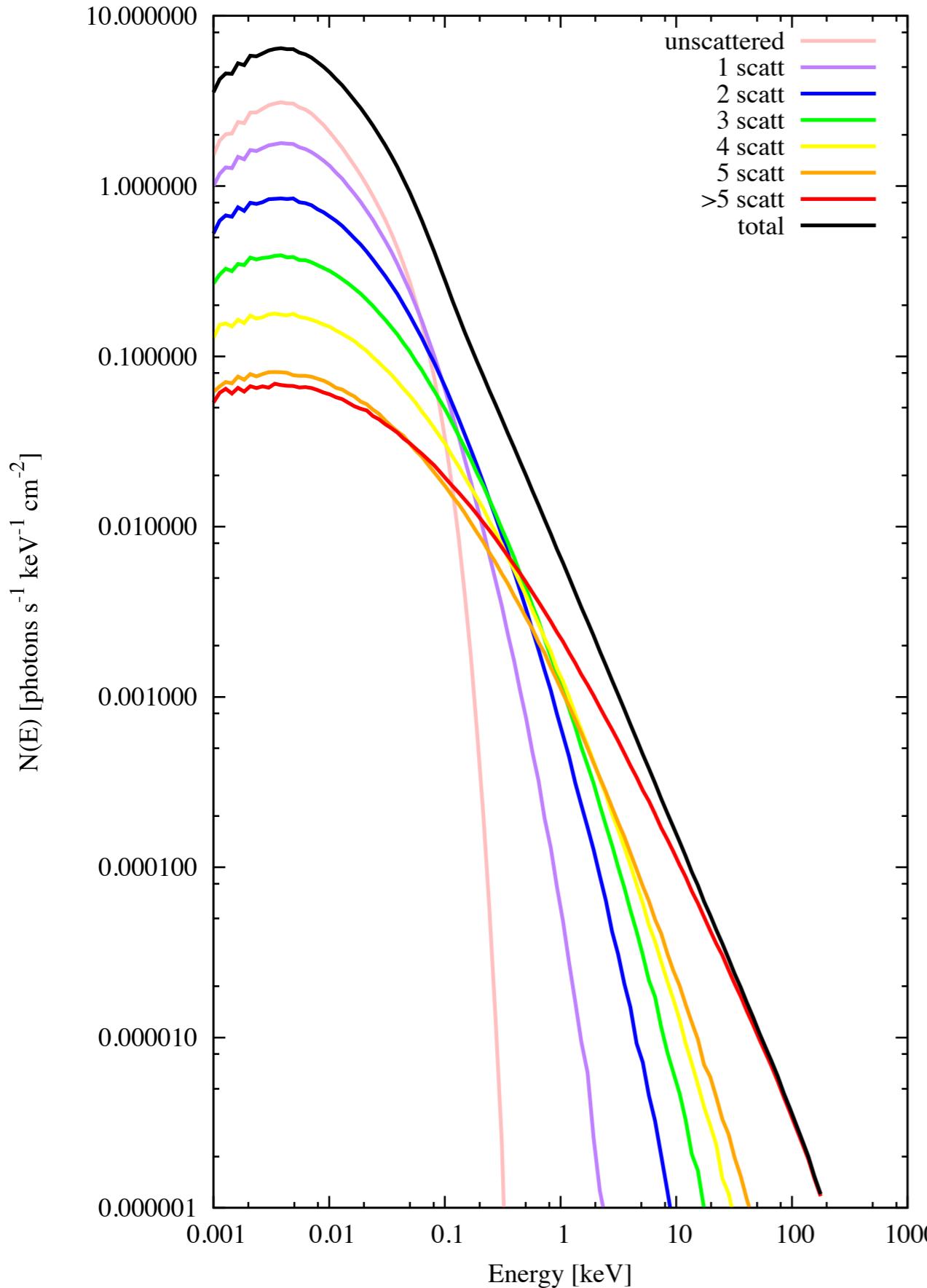
MoCA works in a fully special relativistic scenario (and soon with GR as well), it includes quantum effects (i.e. Klein-Nishina cross-section), it is modular and it works with single photons without any particular approximation or limitation.

For the corona we implemented the two geometries sketched below



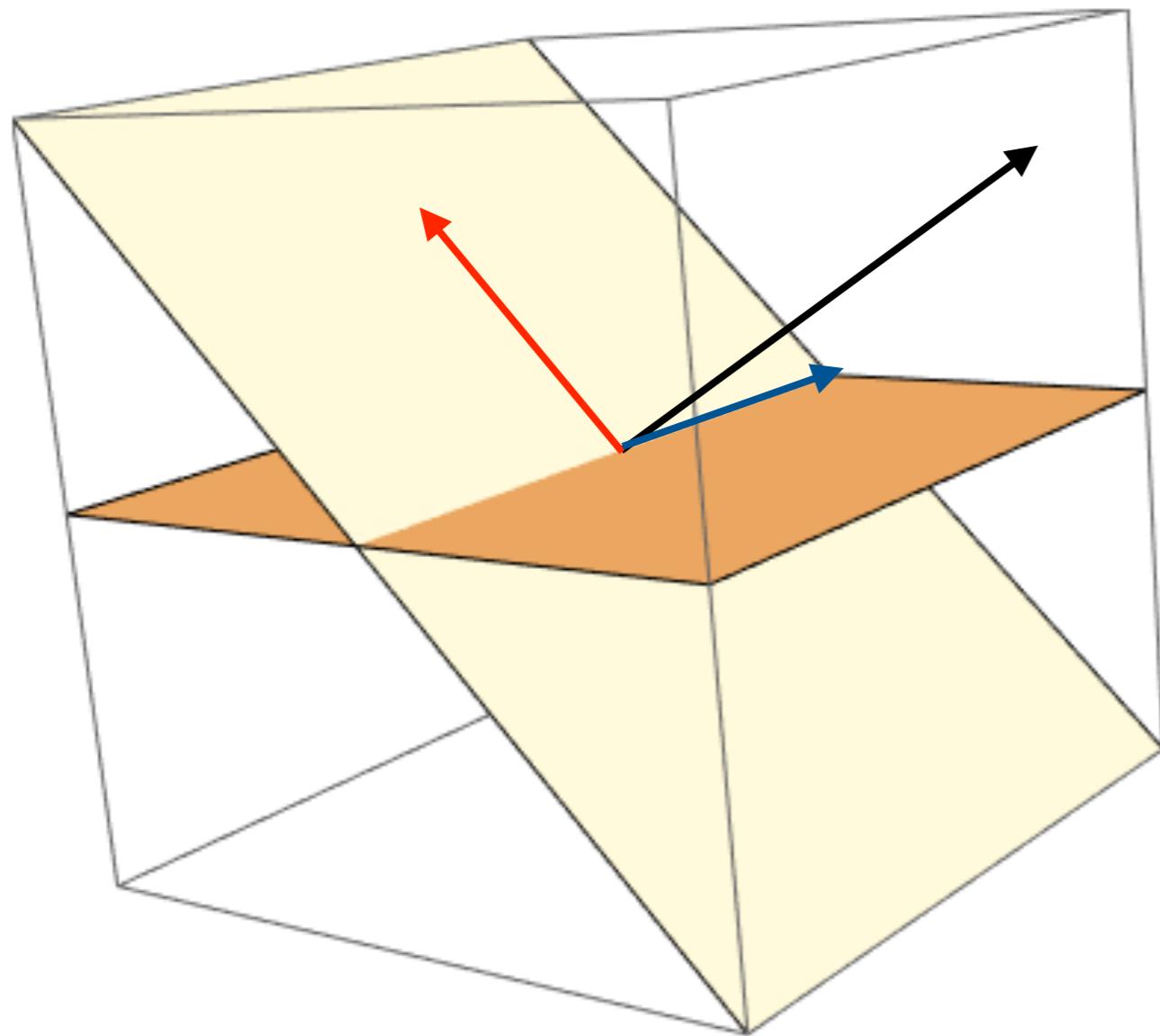
SPECTRA IN MOCA

Spectrum (disc 6-500, mdot1, MBH7) SLAB tau1 kT 100 - logN - 100 bins

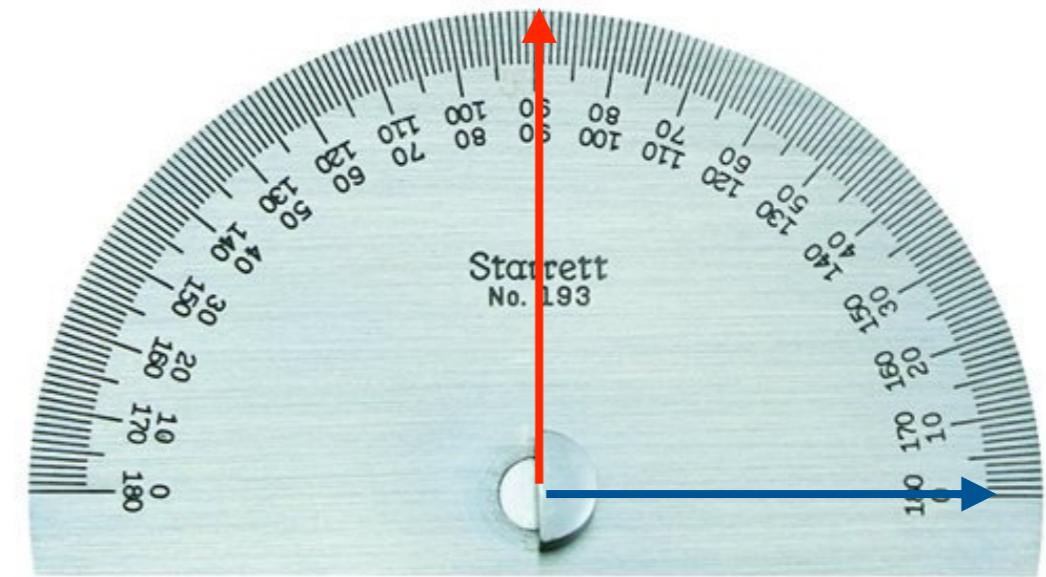
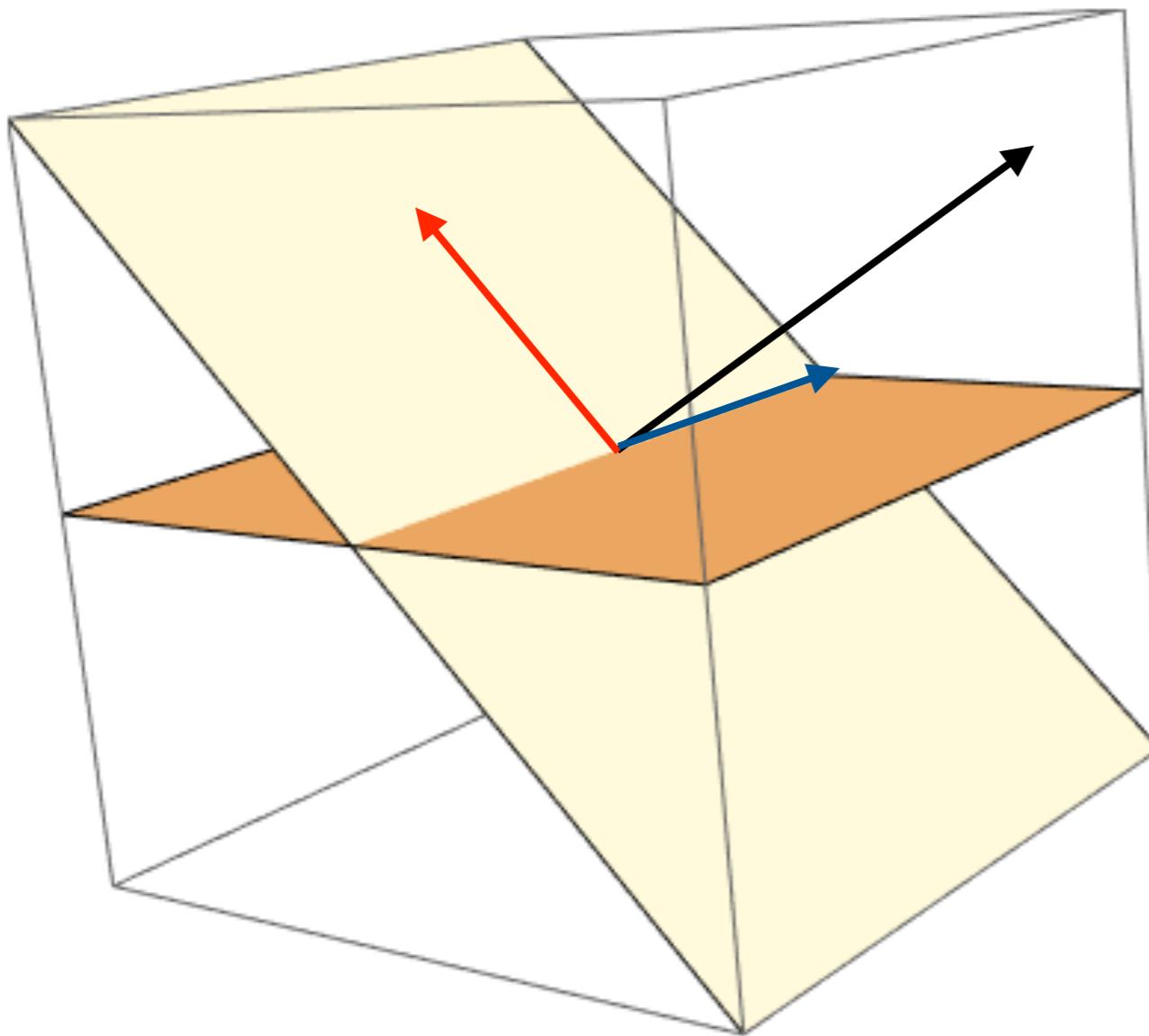


geom tau-kT	MoCA	compPS
SLAB 1-100	-1.63	-1.61
SLAB 0.5-100	-1.95	-1.97
SLAB 1-50	-2.31	-2.08
SLAB 0.5-50	-2.79	-2.50
SPHERE 1-100	-1.95	-1.96
SPHERE 0.5-100	-2.28	-2.38
SPHERE 1-50	-2.57	-2.59
SPHERE 0.5-50	-3.29	-3.20

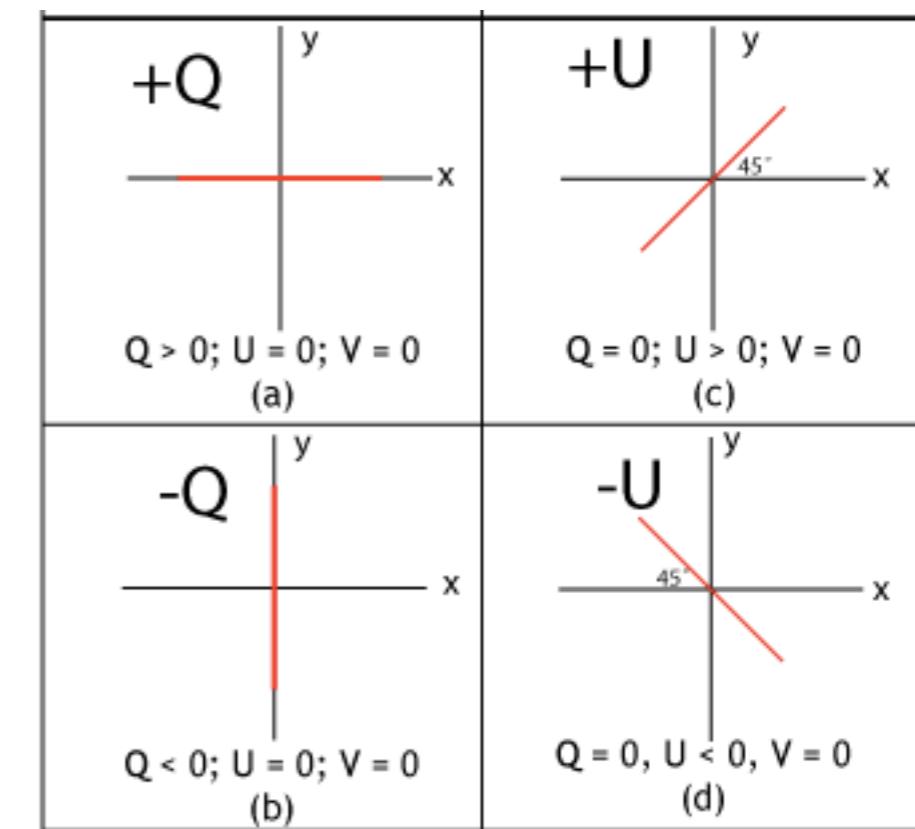
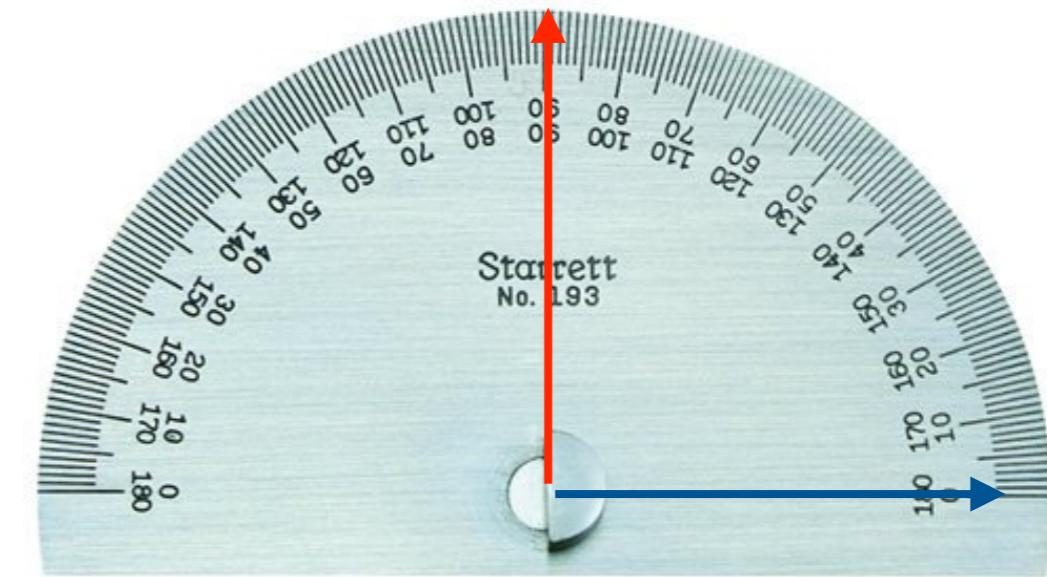
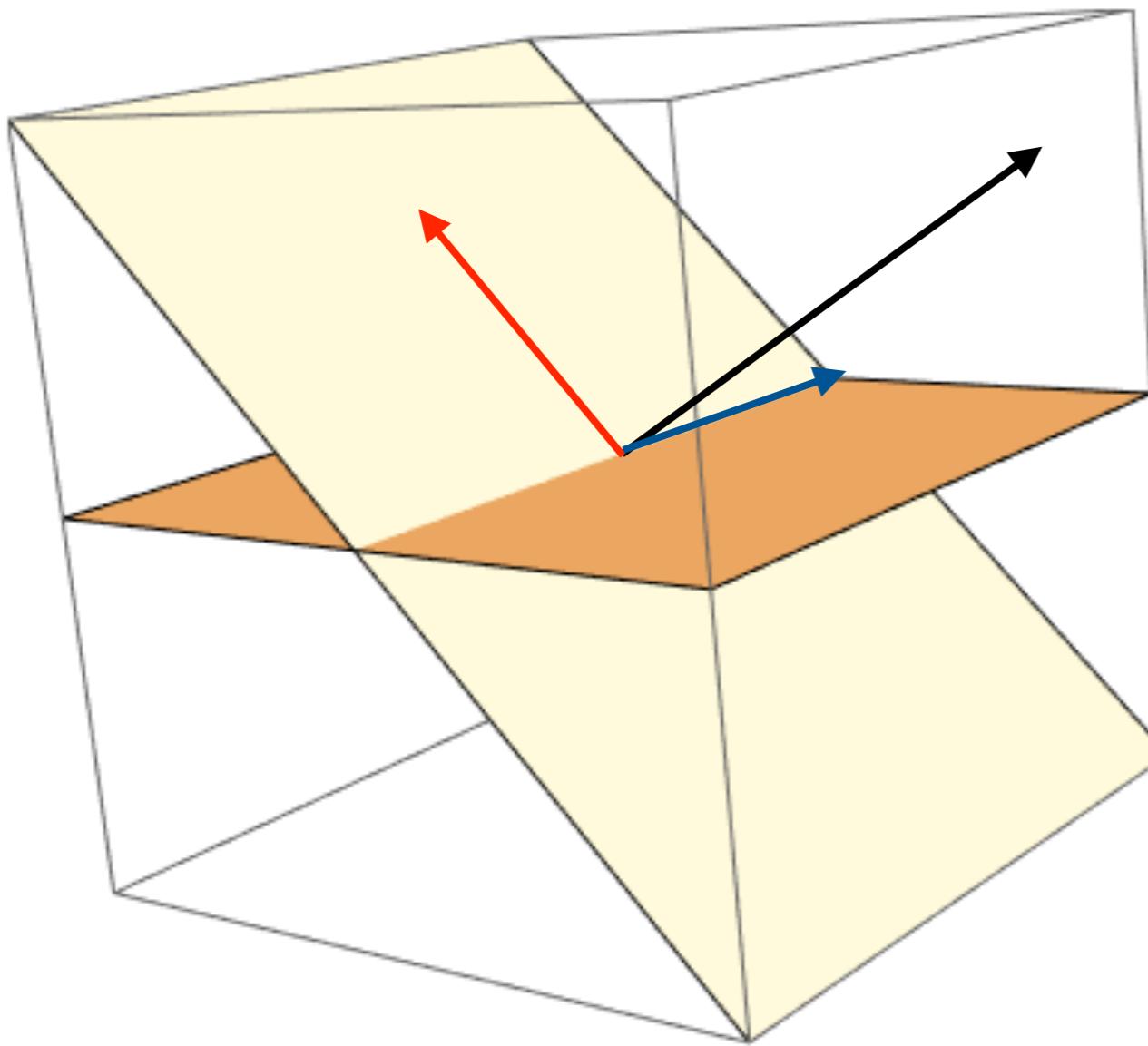
POLARISATION SIGNAL IN MOCA



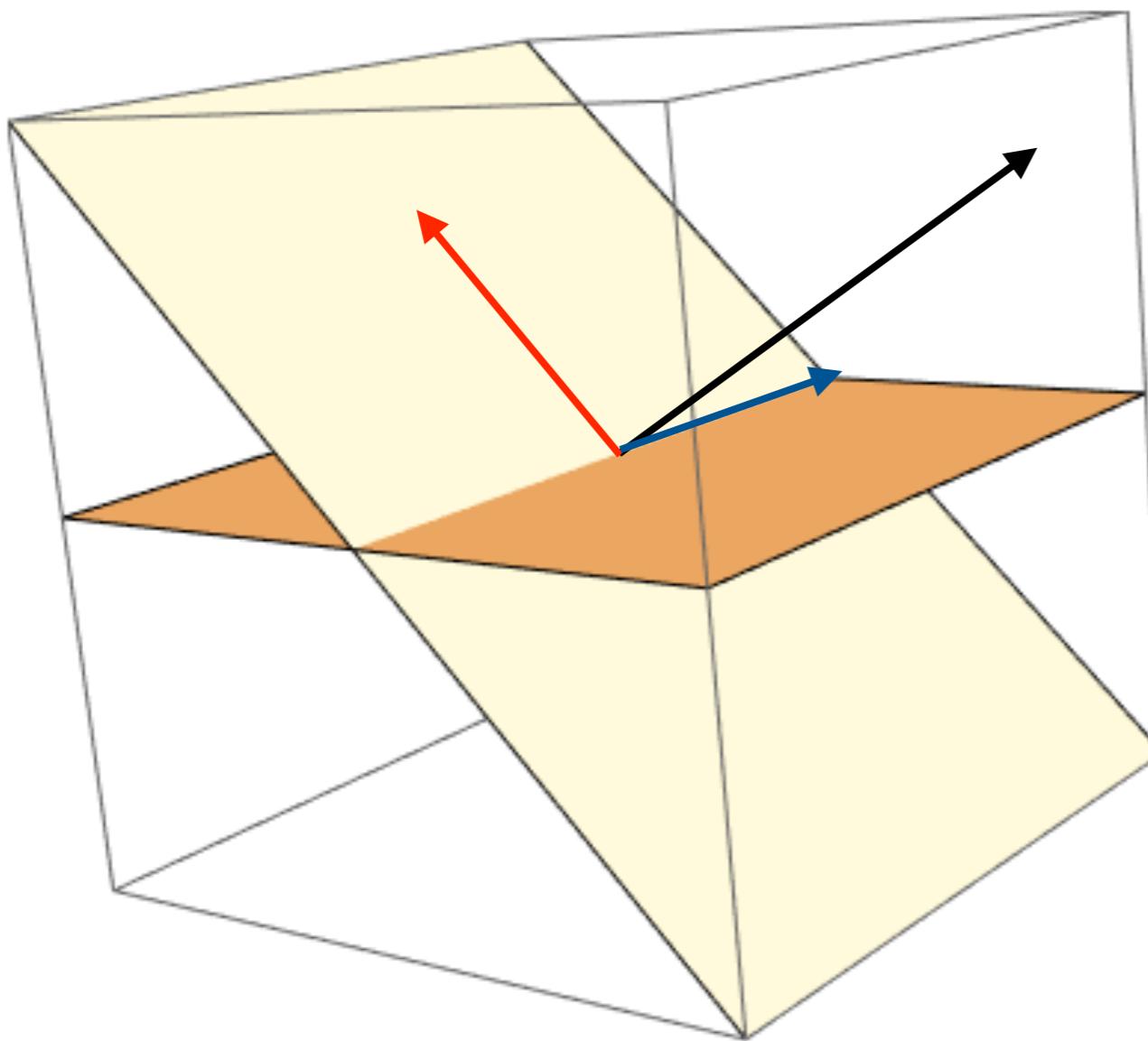
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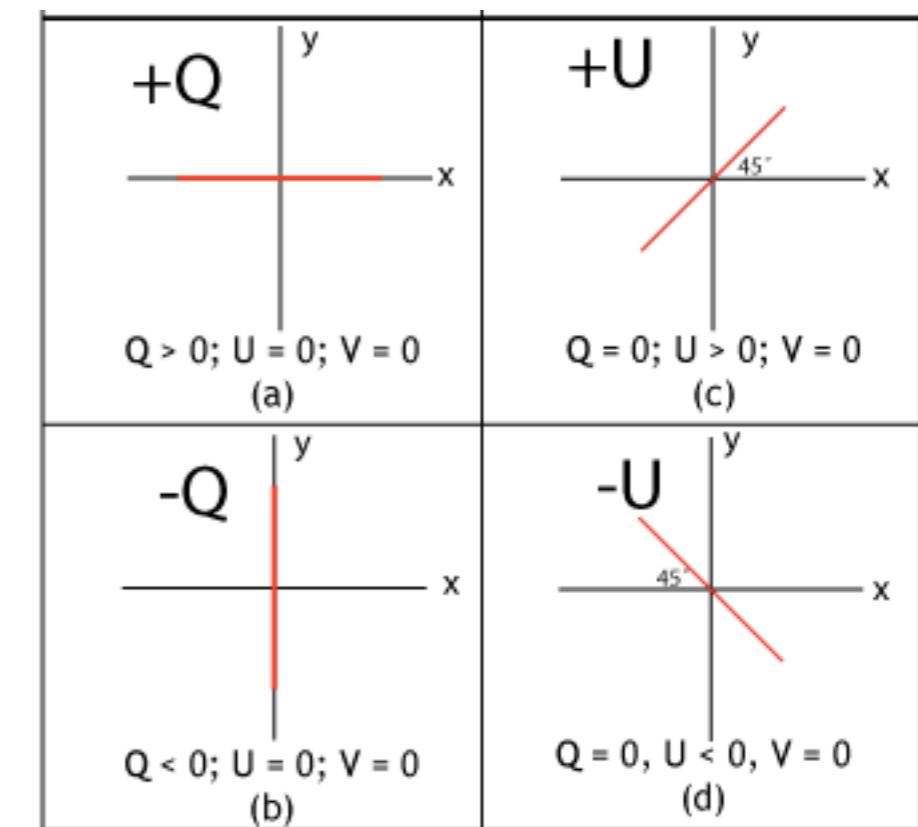
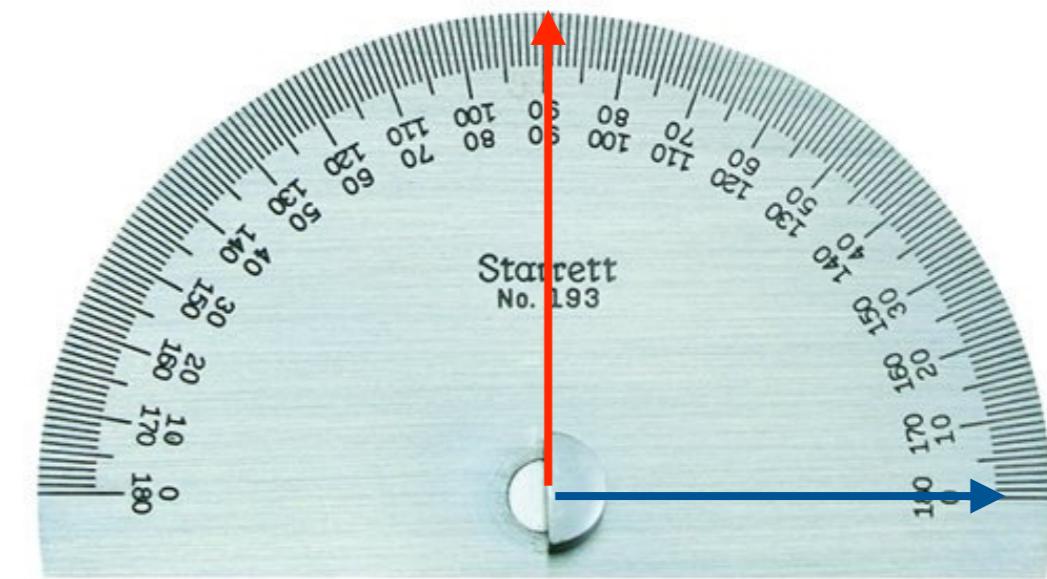


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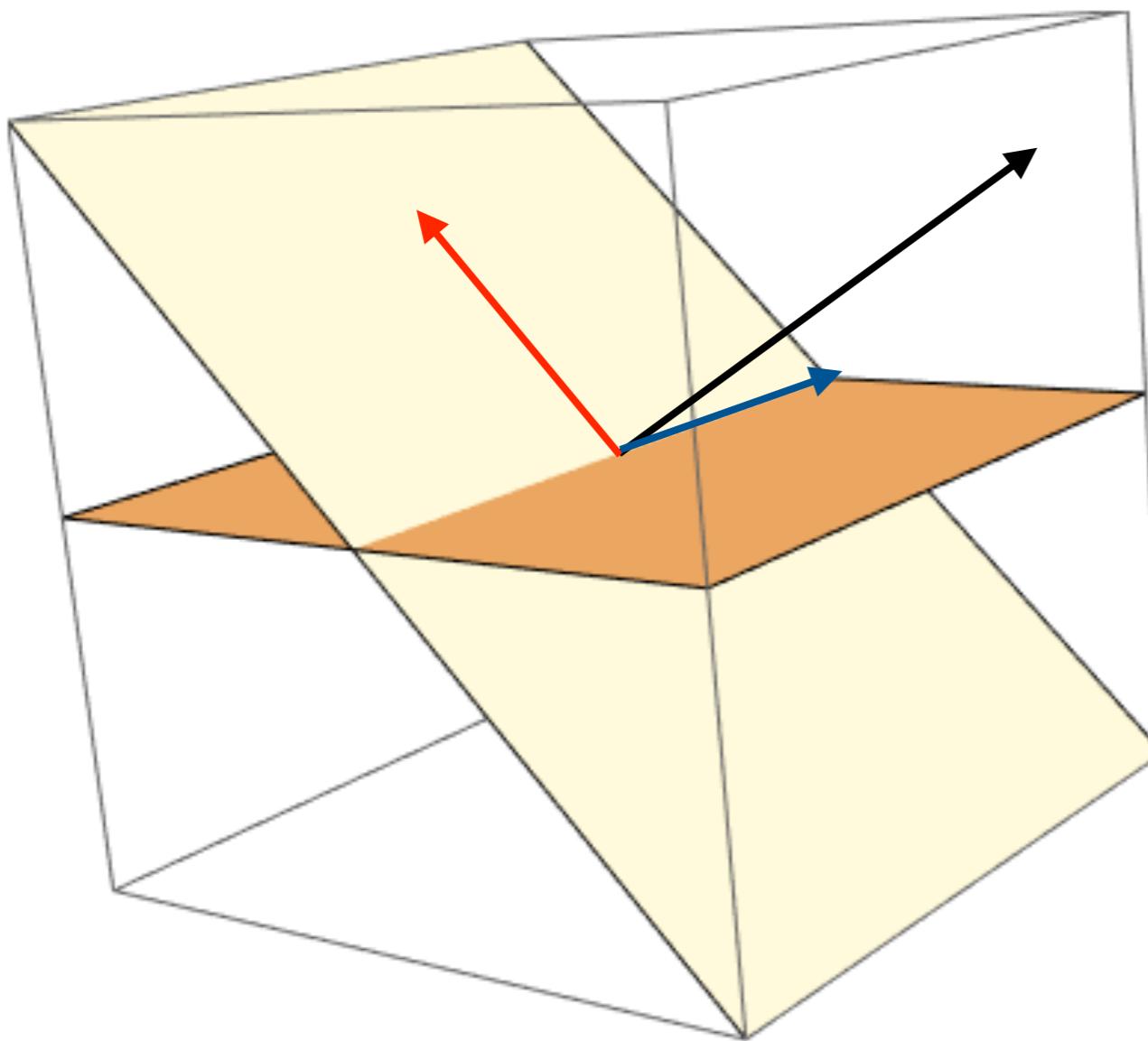


$$\Pi = \frac{\sqrt{Q^2 + U^2}}{I}$$

$$\chi = \frac{1}{2} \arctan \frac{U}{Q}$$



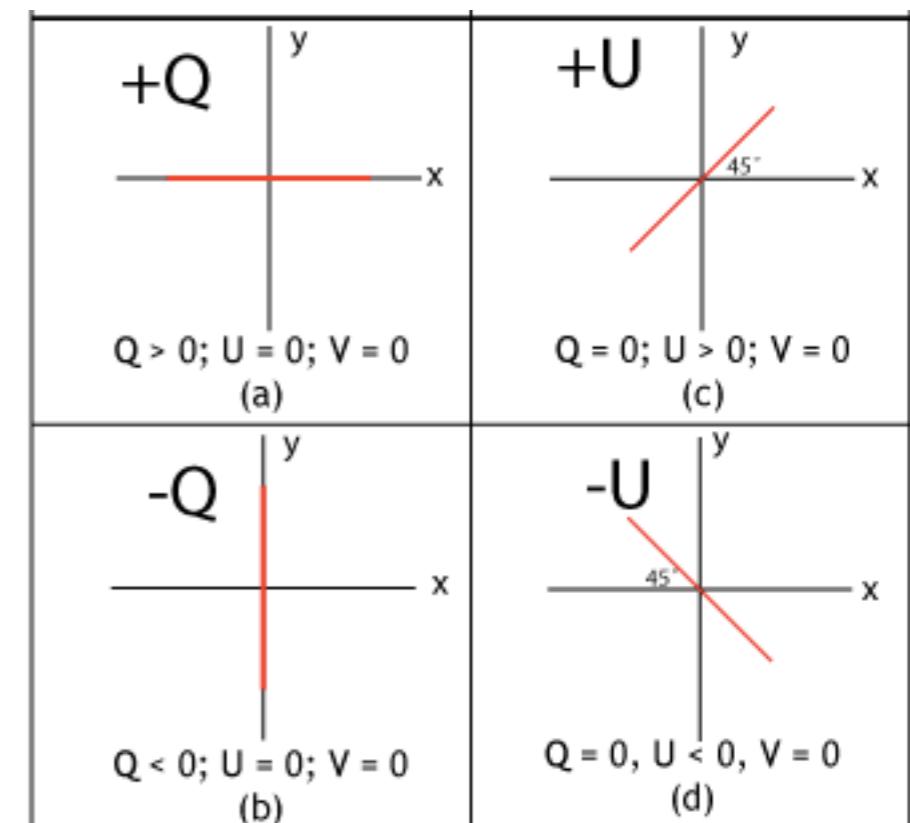
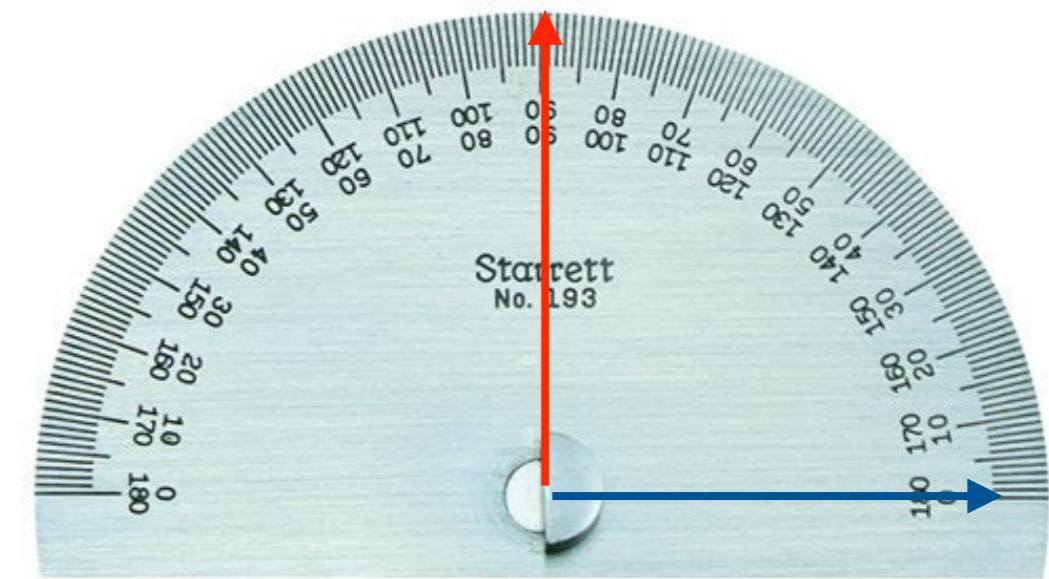
POLARISATION SIGNAL IN MOCA



if $U \sim 0$,
 $\Pi = Q / I$
 the sign of Q
 representing the angle
 of polarisation

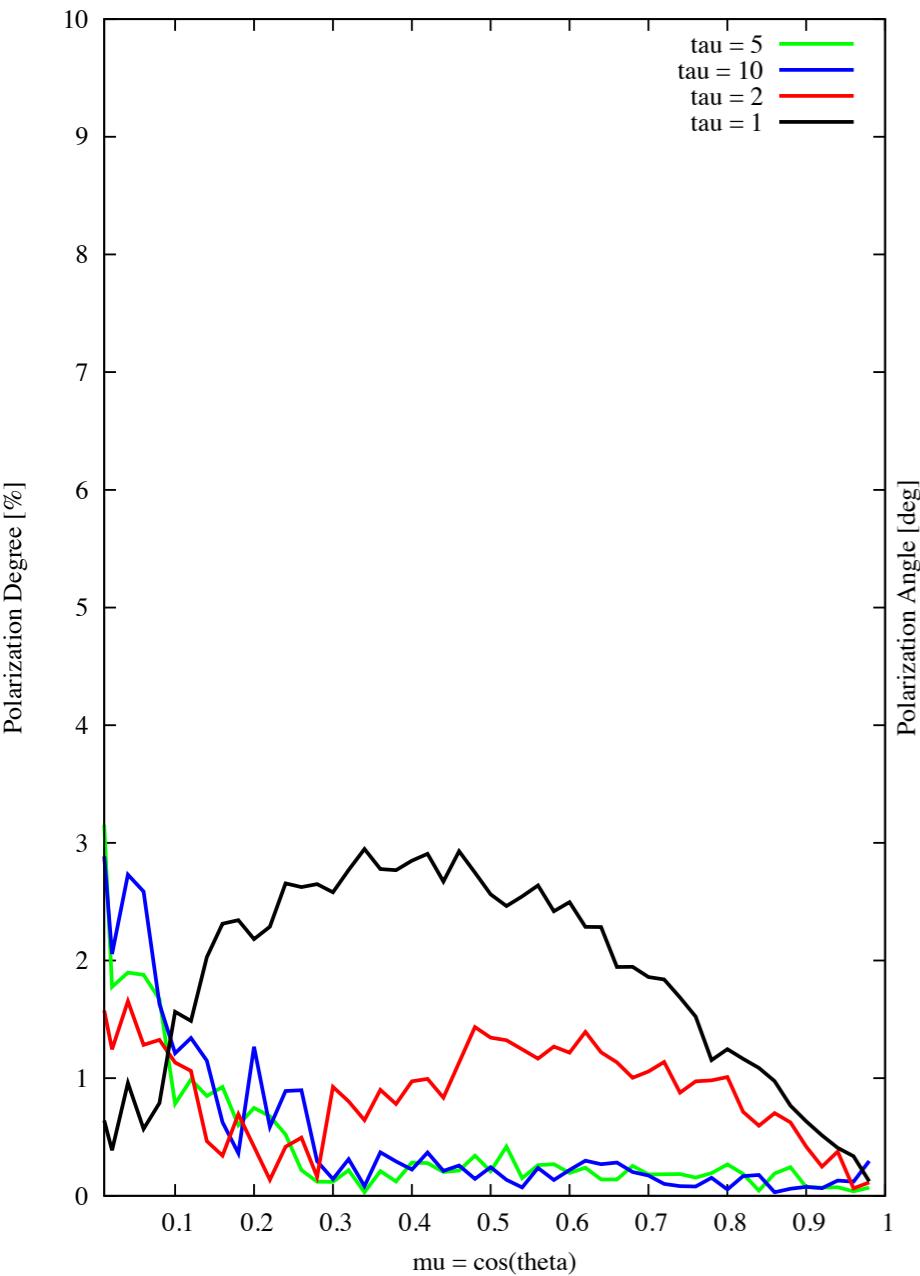
$$\Pi = \frac{\sqrt{Q^2 + U^2}}{I}$$

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POLARISATION SIGNAL REPRESENTATION

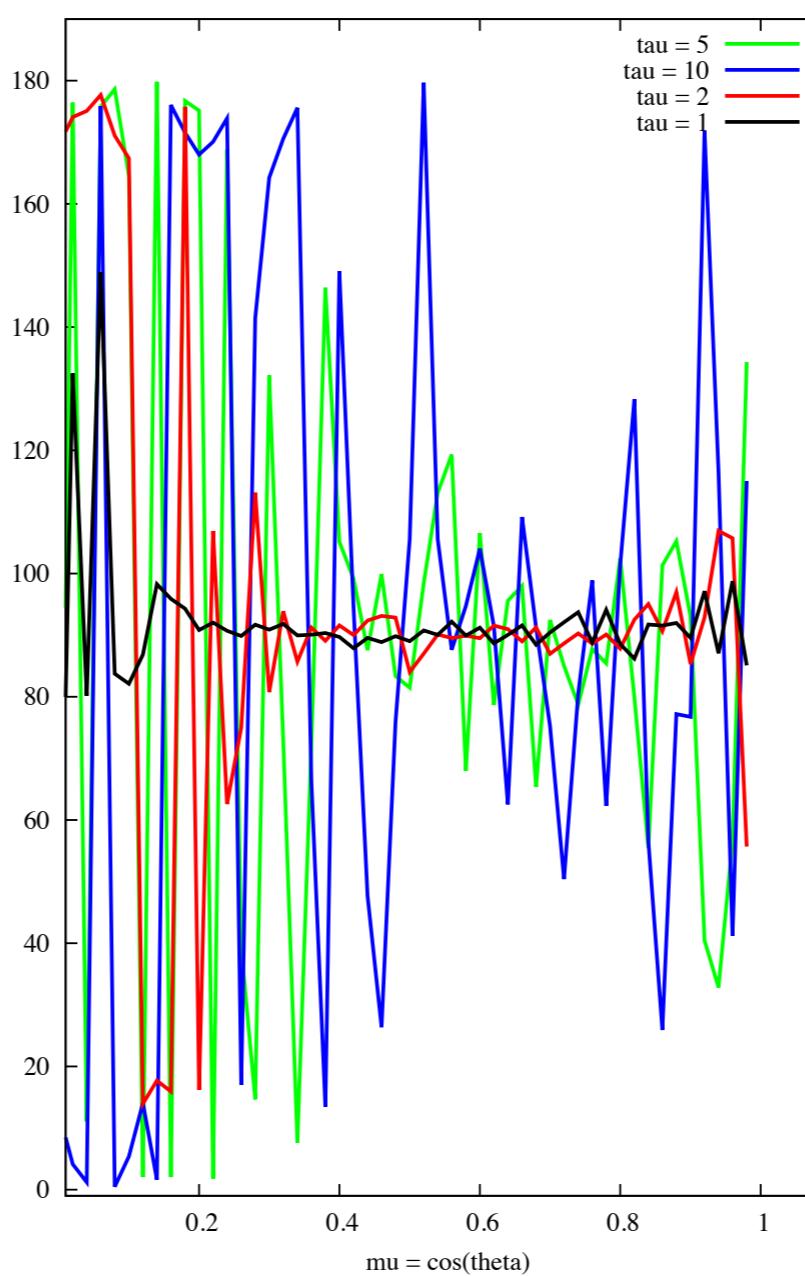
Polarization degree (disc 6-500, mdot1, MBH7) SLAB kT 100 - 50 bins



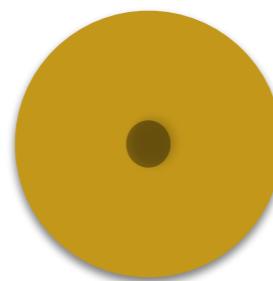
edge-on



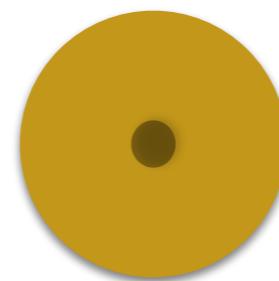
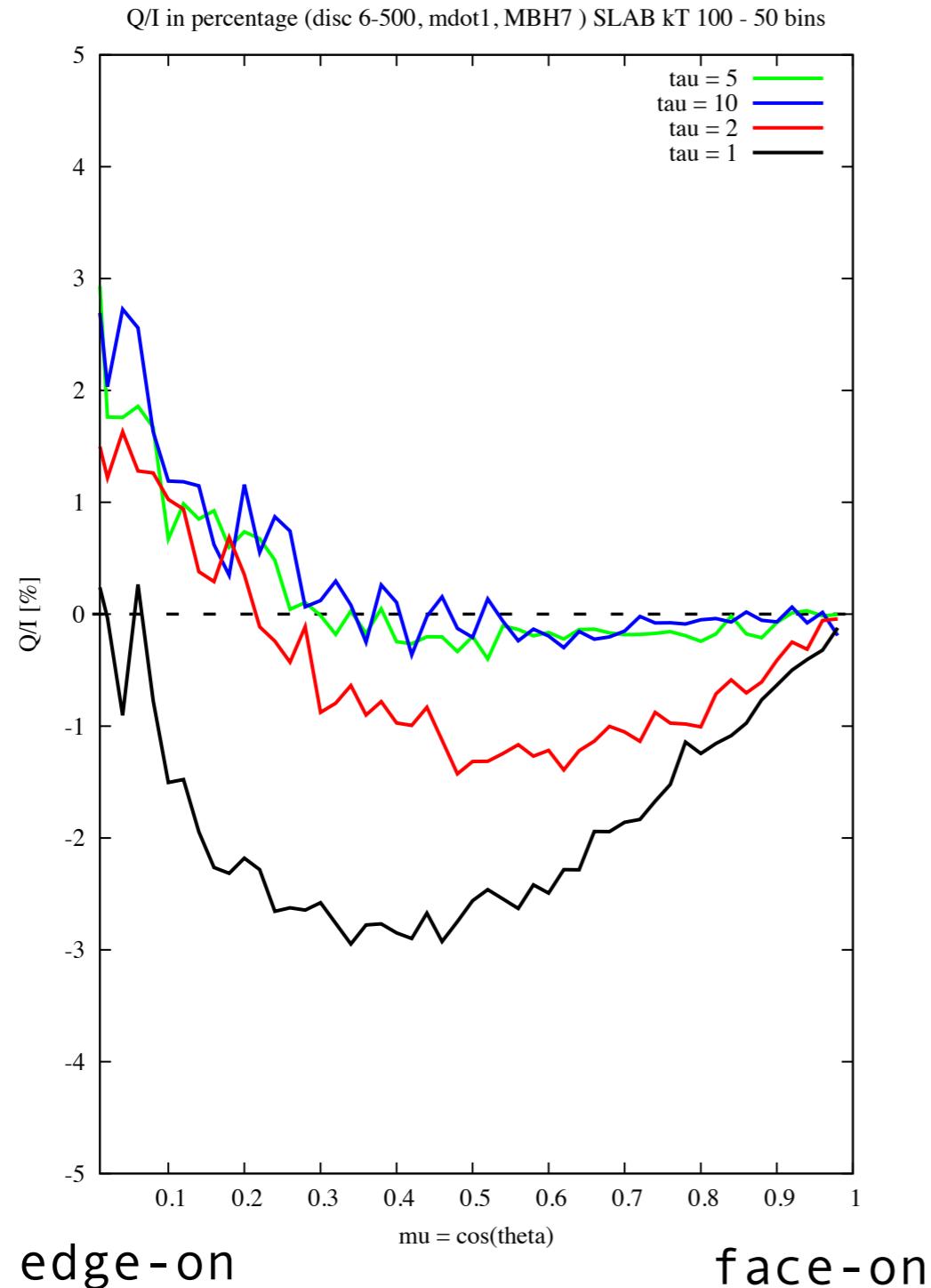
Polarization angle (disc 6-500, mdot1, MBH7) SLAB kT 100 - 50 bins



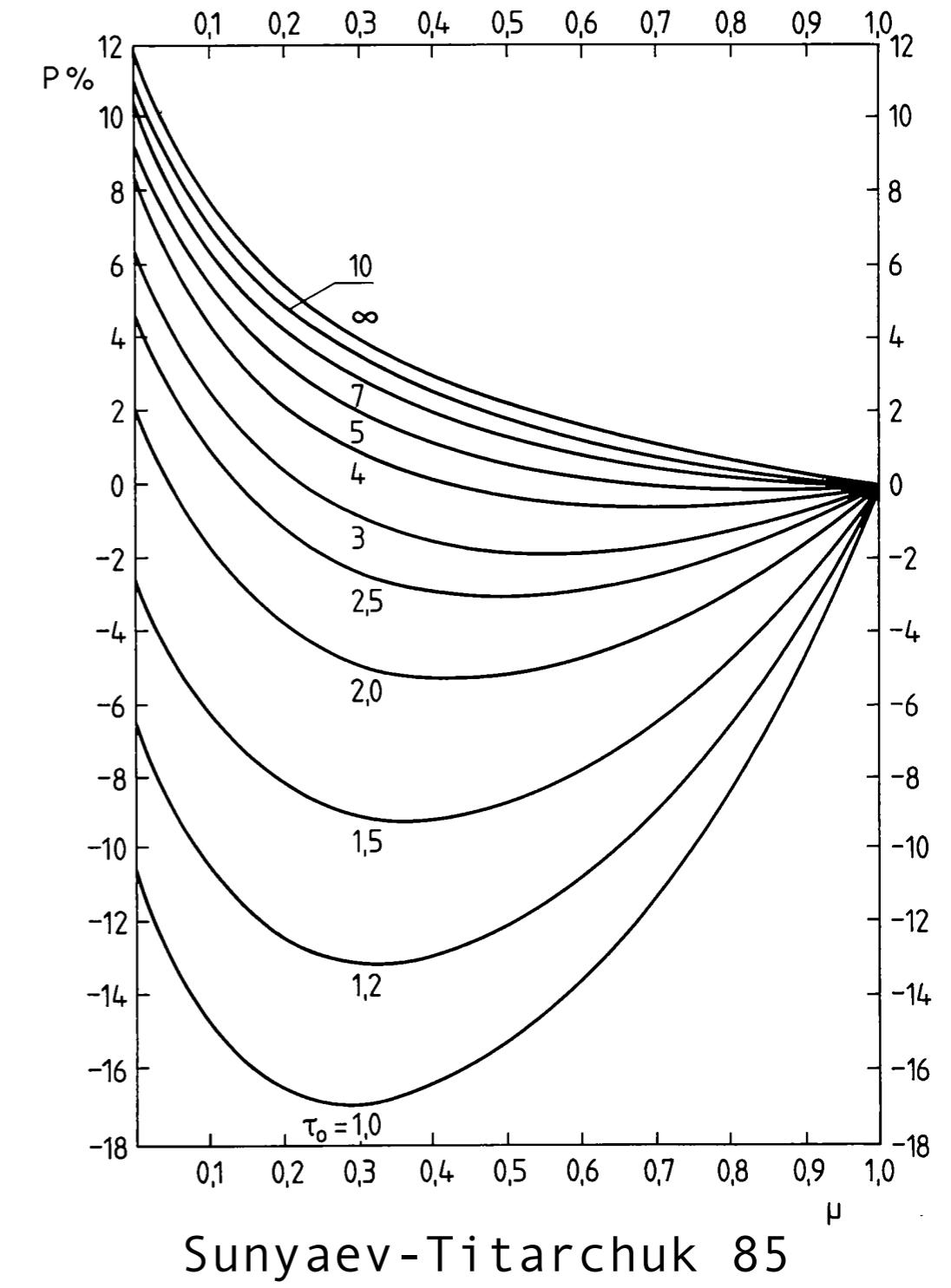
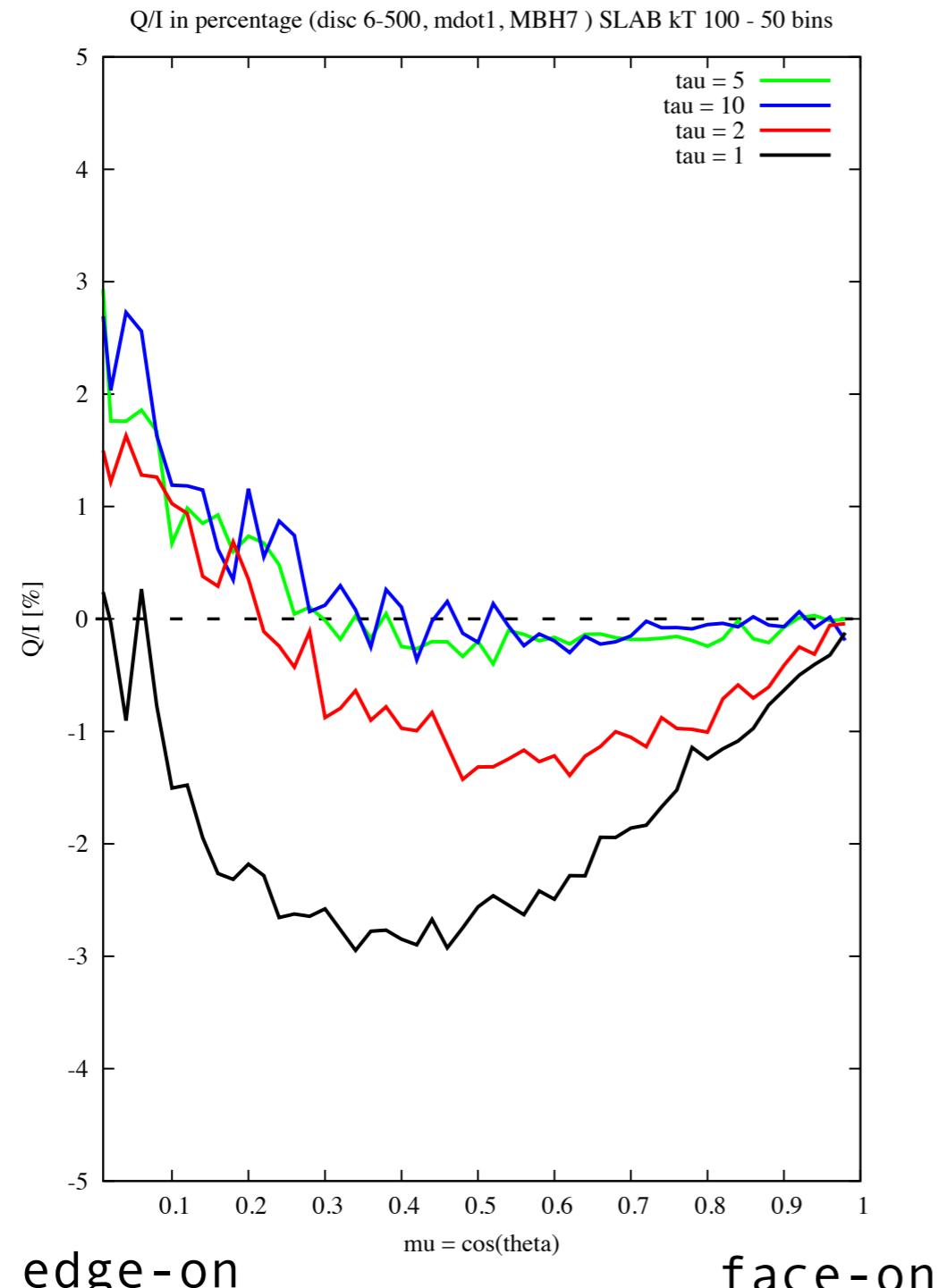
face-on



POLARISATION SIGNAL REPRESENTATION

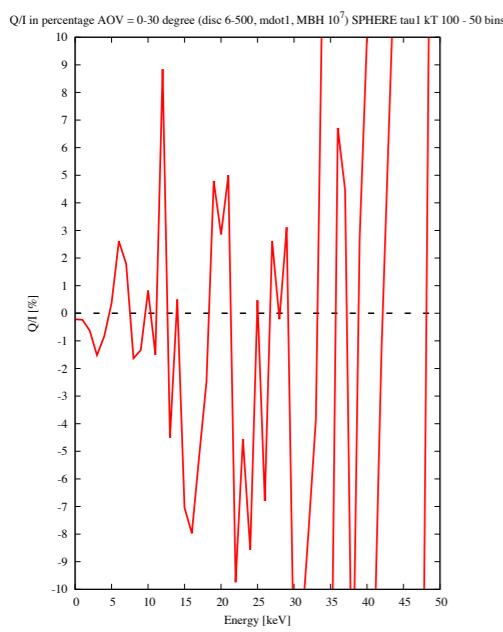


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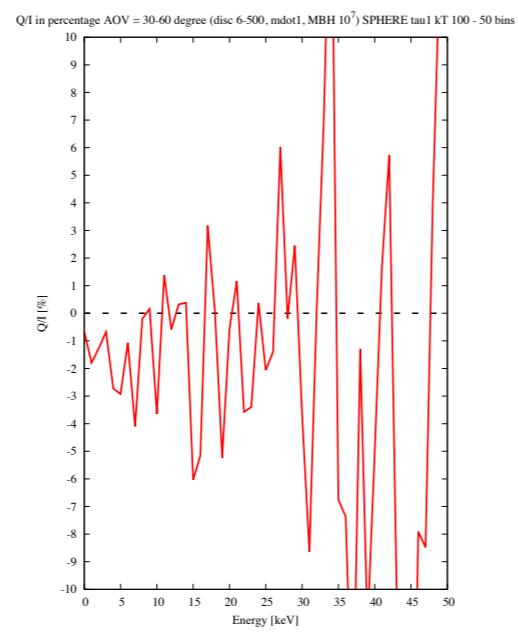


SPHERE tau = 1, kT = 100 keV

LOS = $0^\circ - 30^\circ$



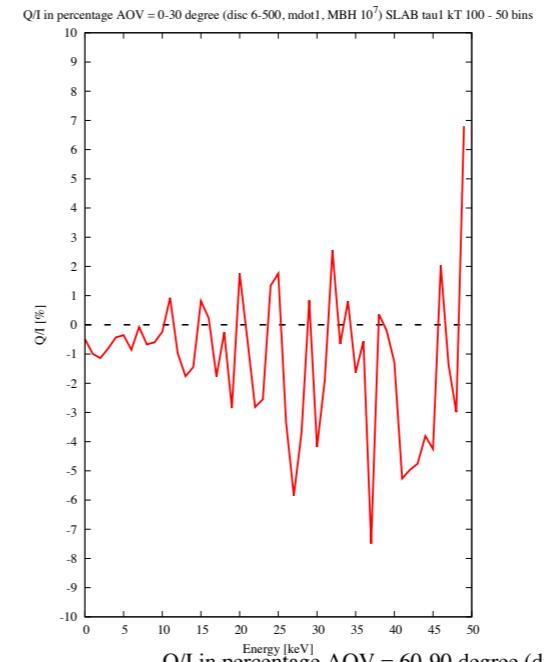
LOS = $30^\circ - 60^\circ$



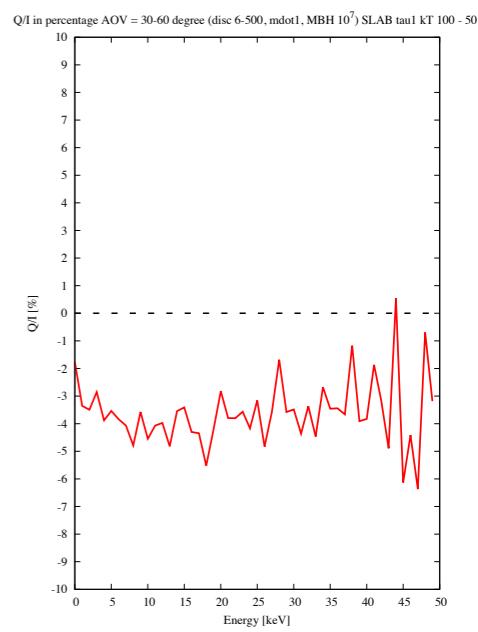
AGN

SLAB tau = 1, kT = 100 keV

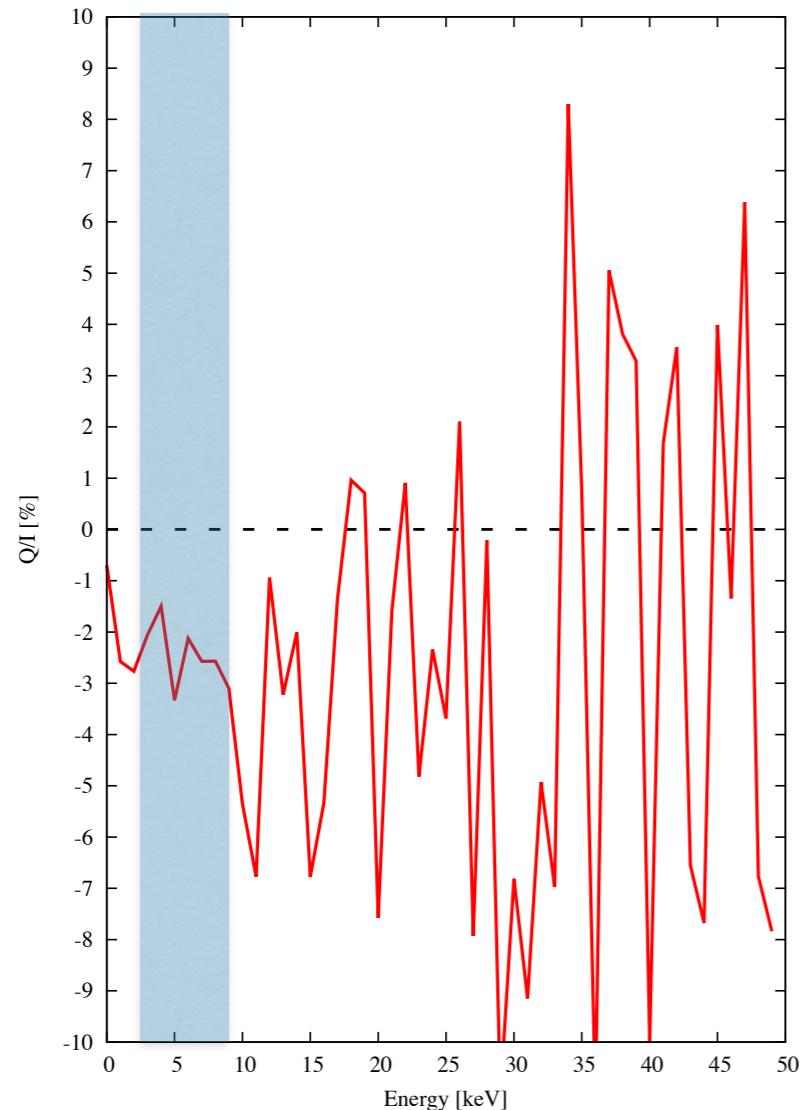
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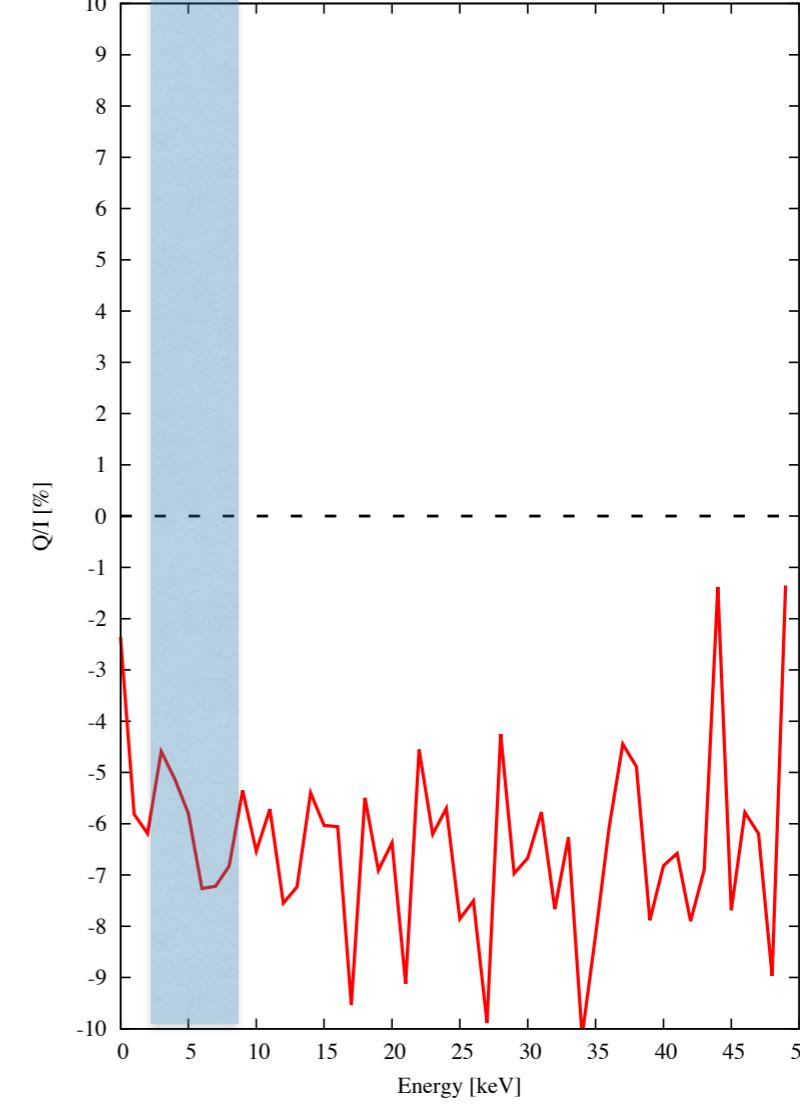
LOS = $30^\circ - 60^\circ$



Q/I in percentage AOV = 60-90 degree (disc 6-500, mdot1, MBH 10^7) SPHERE tau1 kT 100 - 50 bins



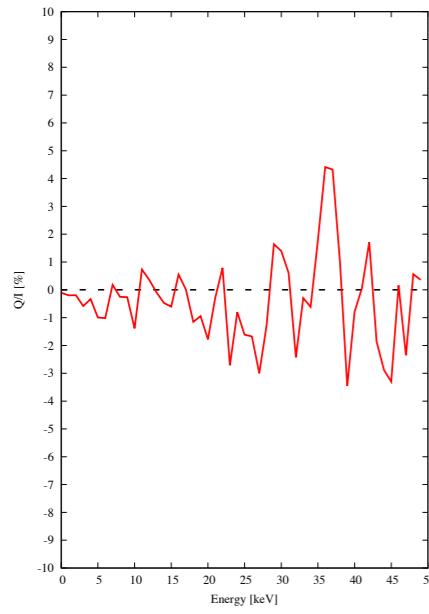
LOS = $60^\circ - 90^\circ$



SPHERE tau = 1, kT = 100 keV

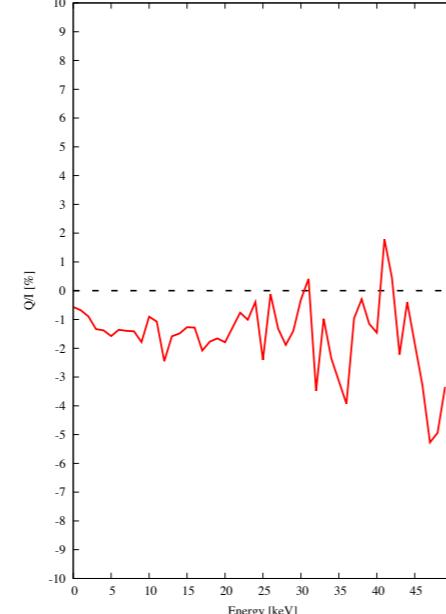
LOS = $0^\circ - 30^\circ$

Q/I in percentage AOV = 0-30 degree (disc 6-500, mdot1, MBH 10Msun) SPHERE tau1 kT 100 - 50 bins



LOS = $30^\circ - 60^\circ$

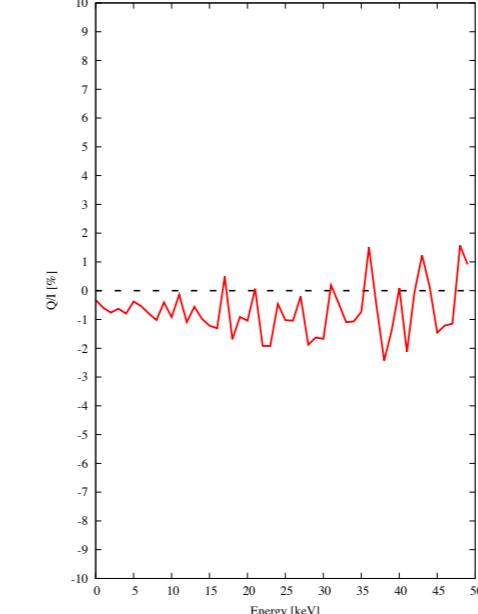
Q/I in percentage AOV = 30-60 degree (disc 6-500, mdot1, MBH 10Msun) SPHERE tau1 kT 100 - 50 bins



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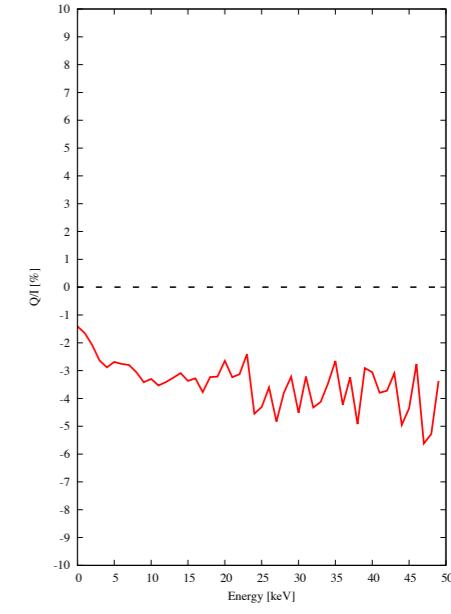
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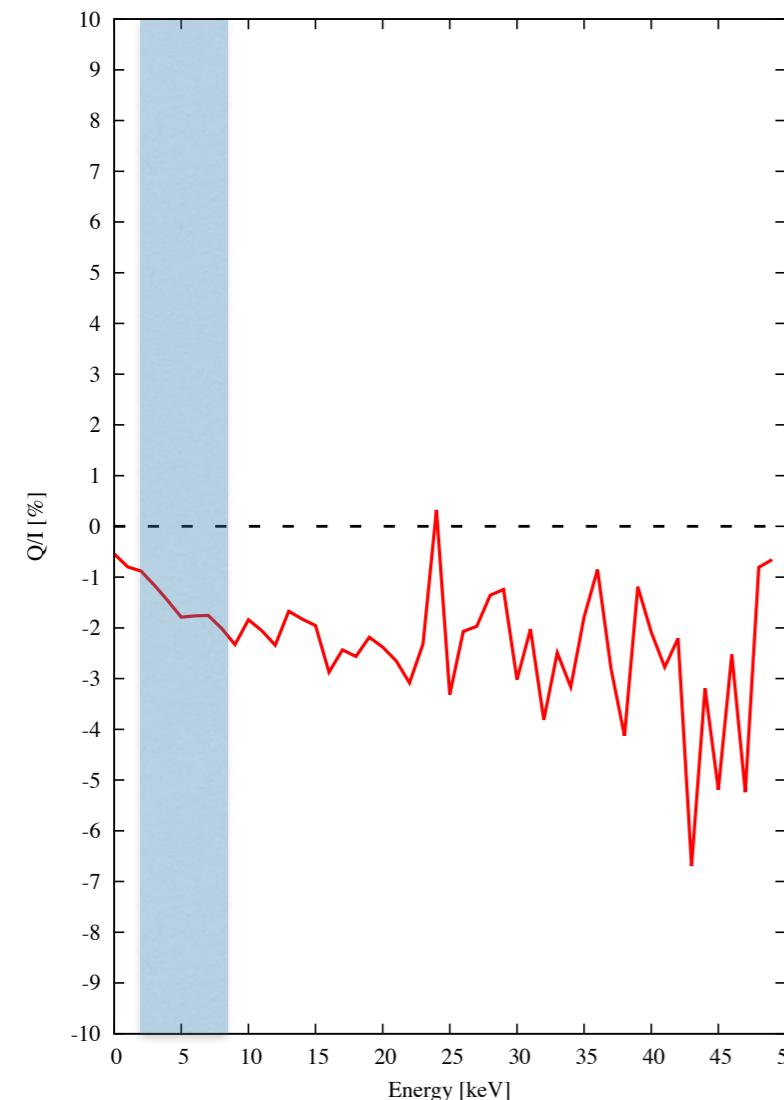


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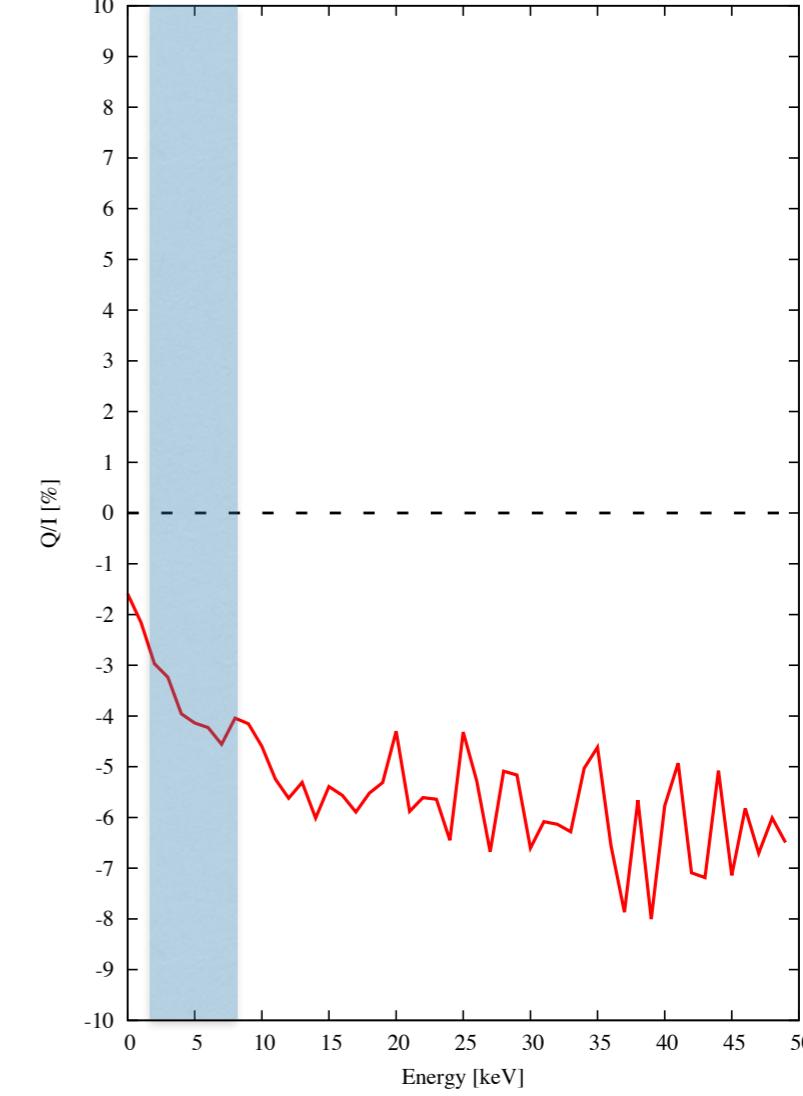


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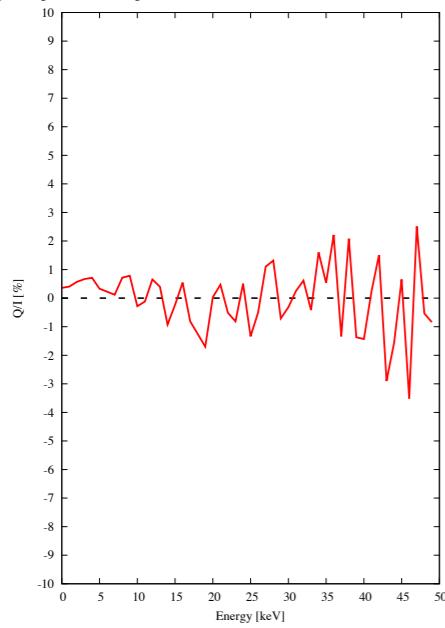
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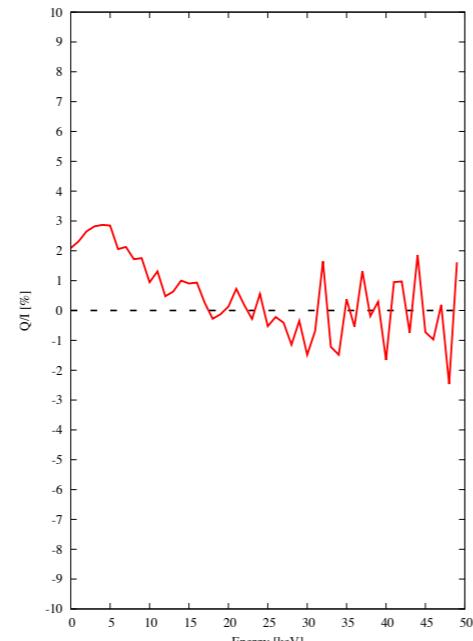
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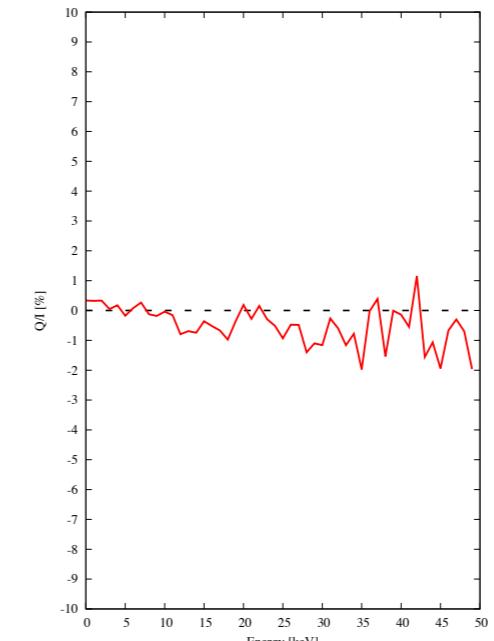


BHB
LIMB

SLAB tau = 1, kT = 100 keV

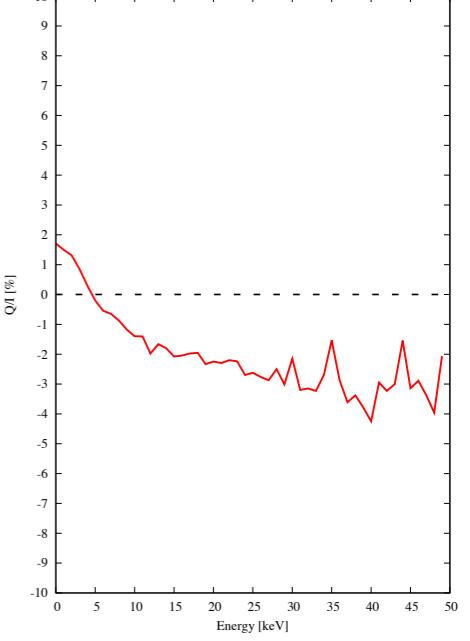
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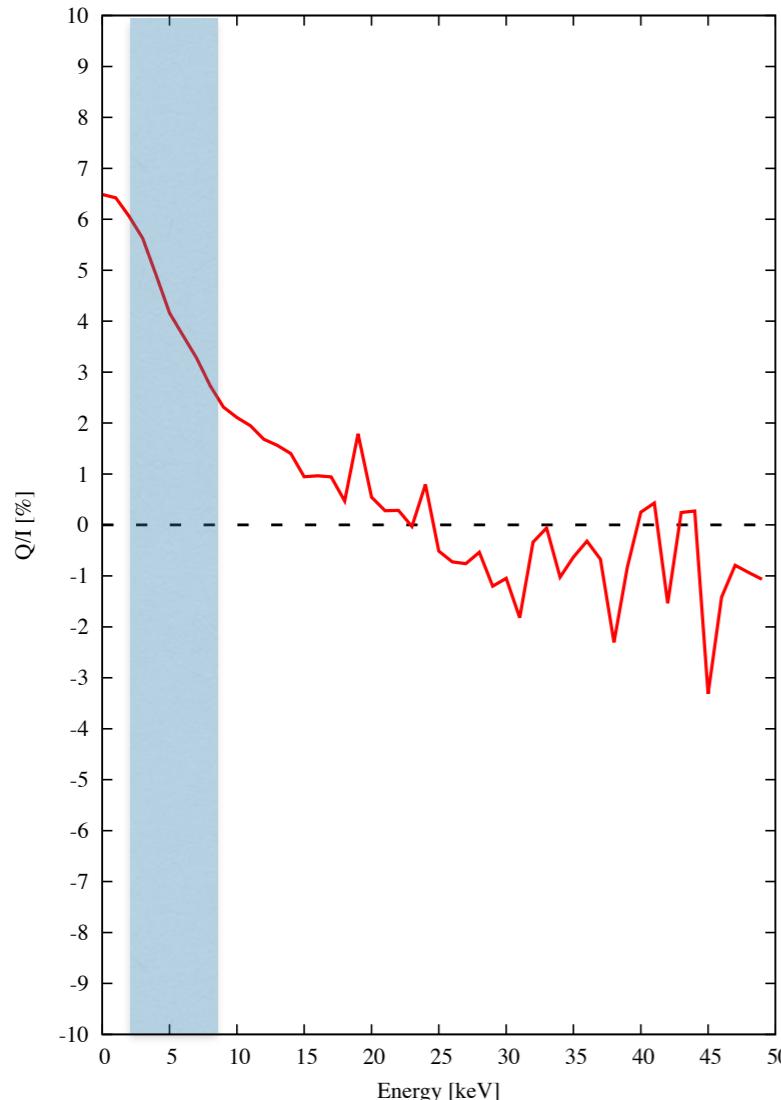


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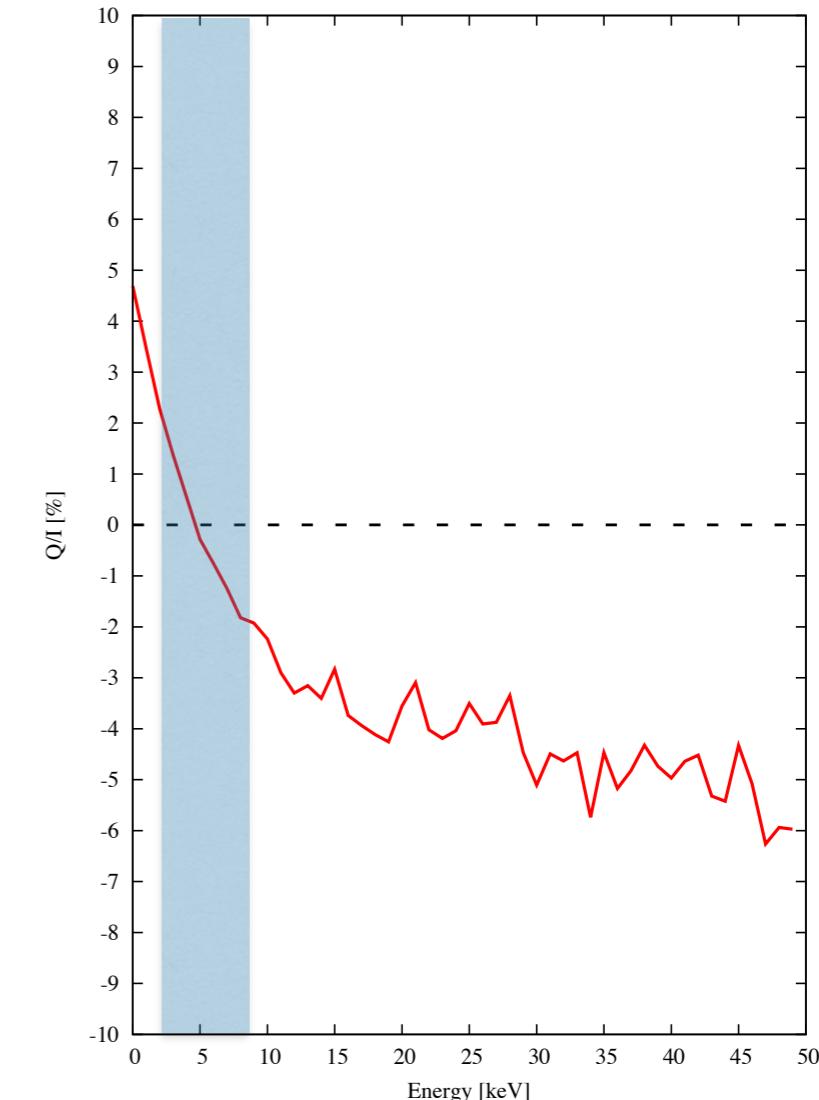
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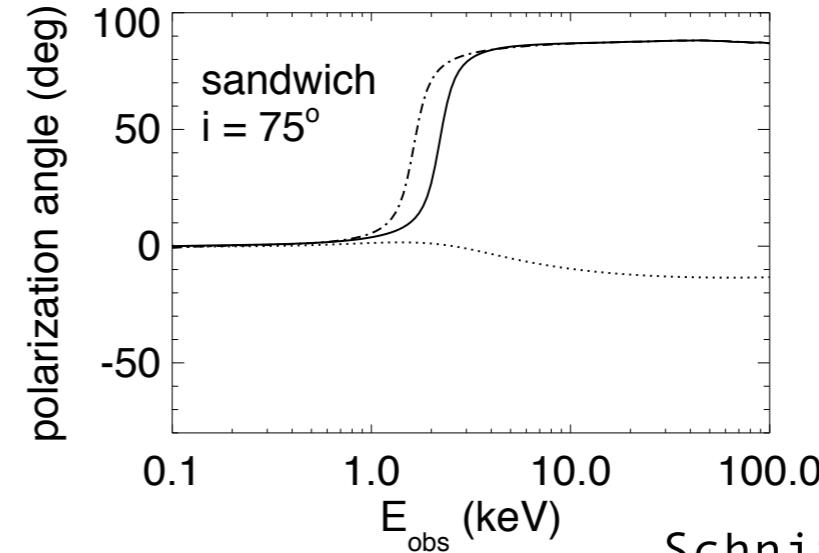
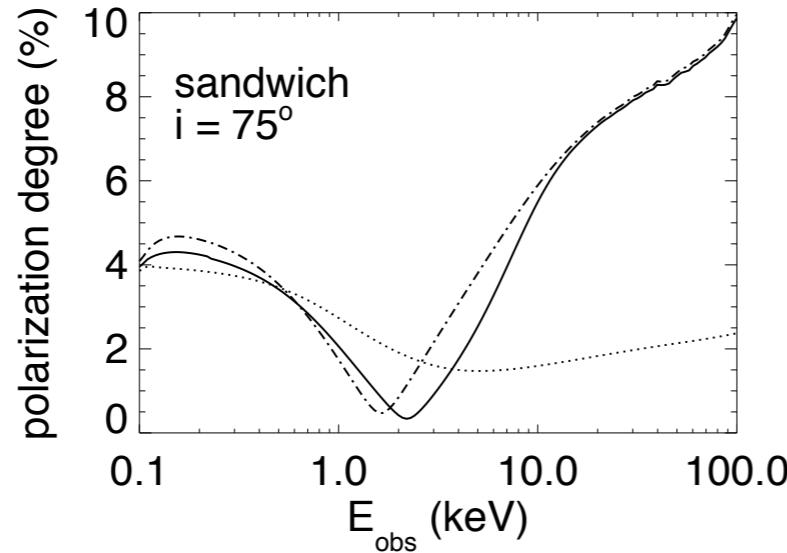
Q/I in percentage AOV = 60-90 degree (disc 6-500, mdot1, MBH 10Msun) LIMB SPHERE tau1 kT 100 - 50 t



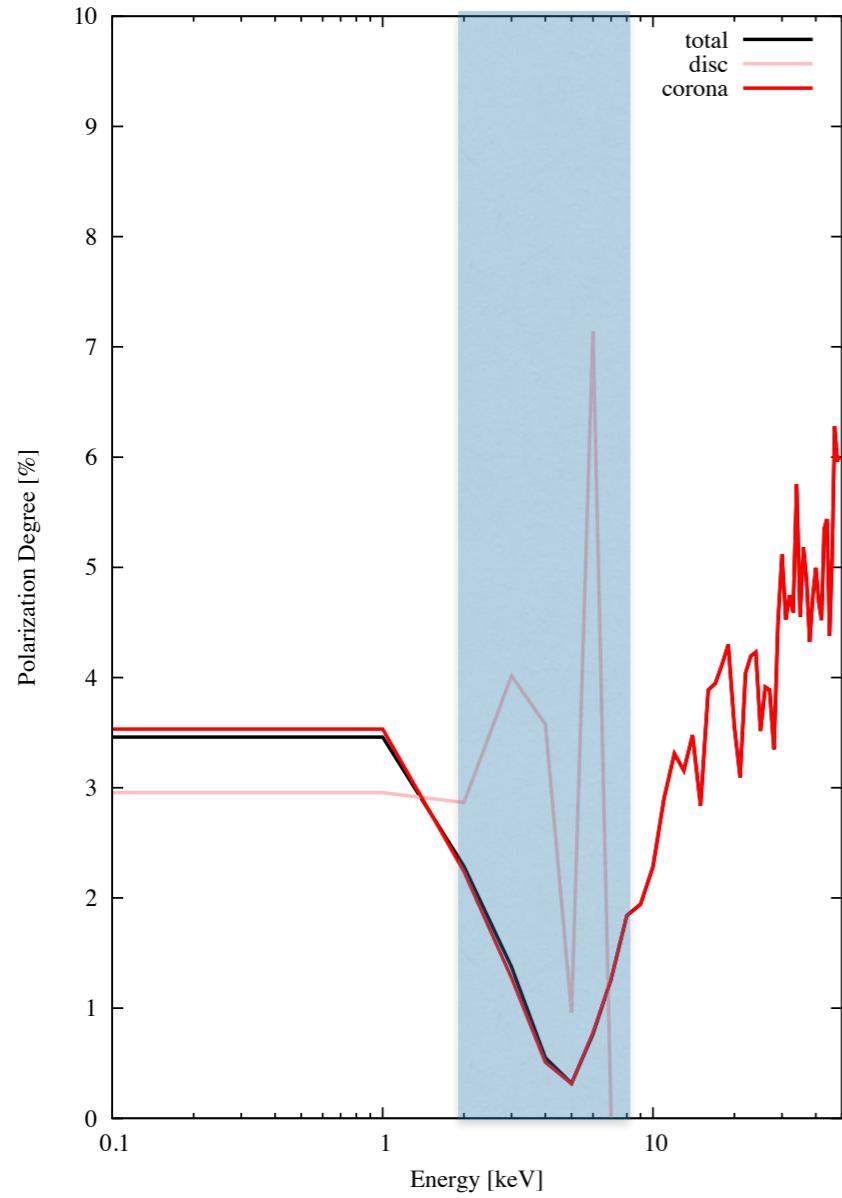
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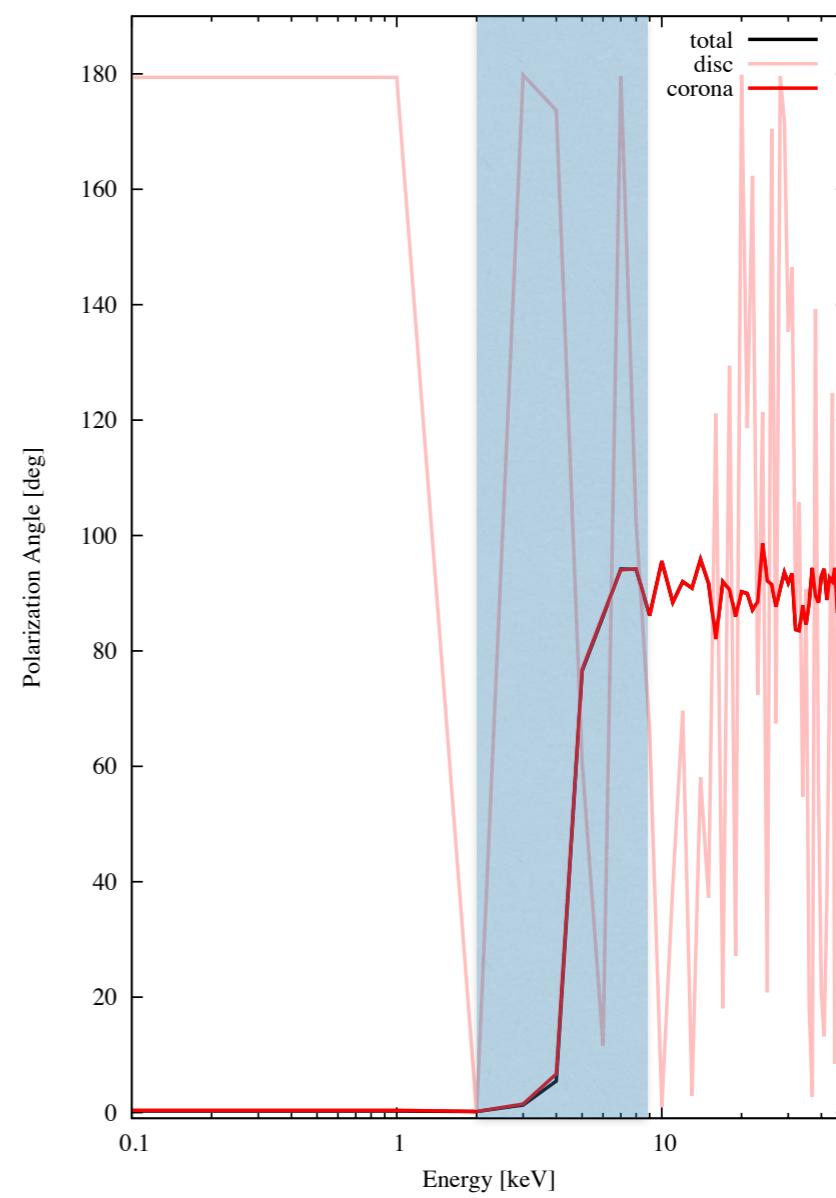
BHB 10 Msun - LIMB SLAB tau = 1, kT = 100 keV



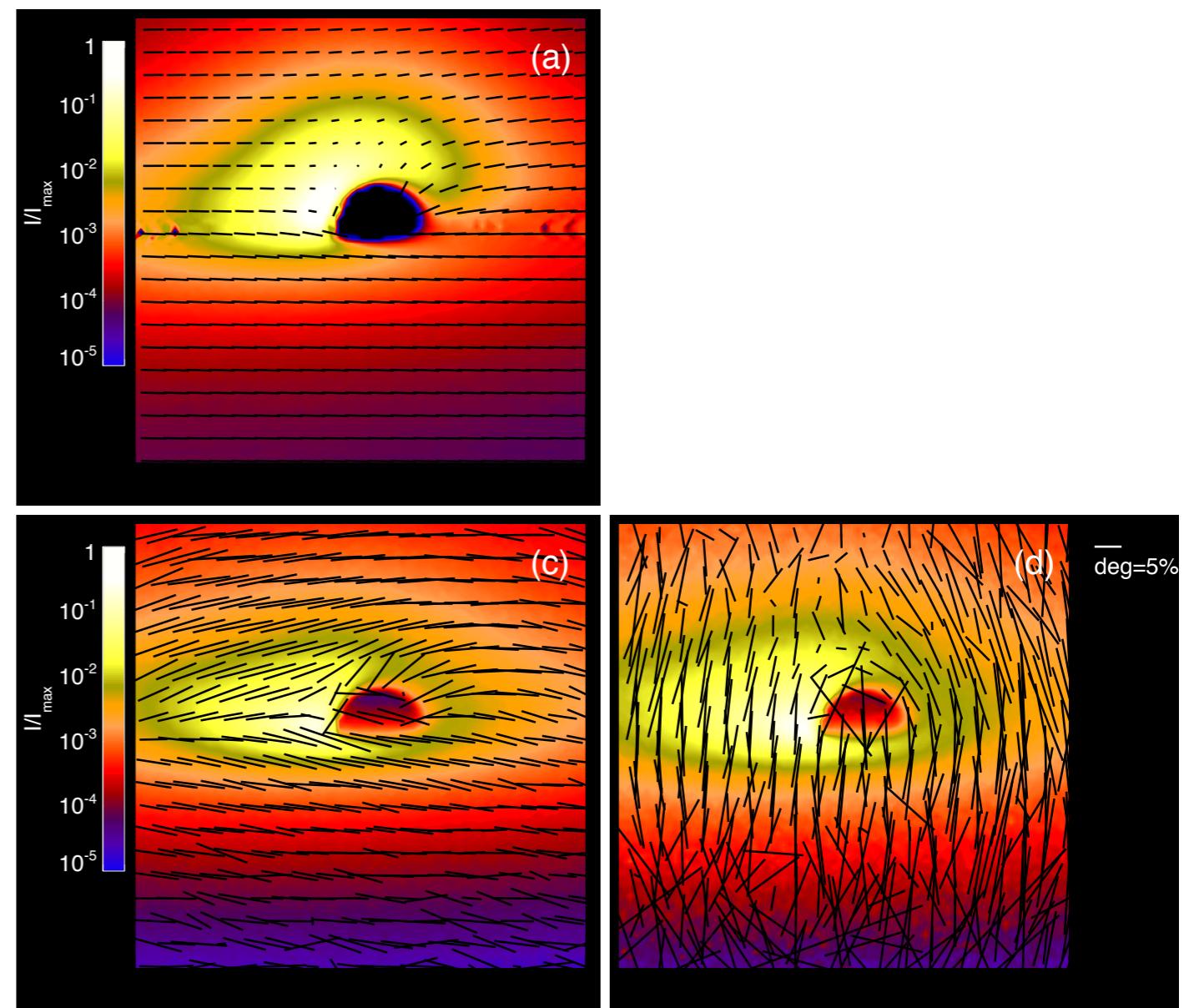
Polarization degree, AOV=60-90 degree (disc 6-500, mdot1, MBH 10Msun) SLAB LIMB tau1 kT 100 - 50



Polarization angle, AOV=60-90 degree (disc 6-500, mdot1, MBH 10Msun) SLAB LIMB tau1 kT 100 - 50



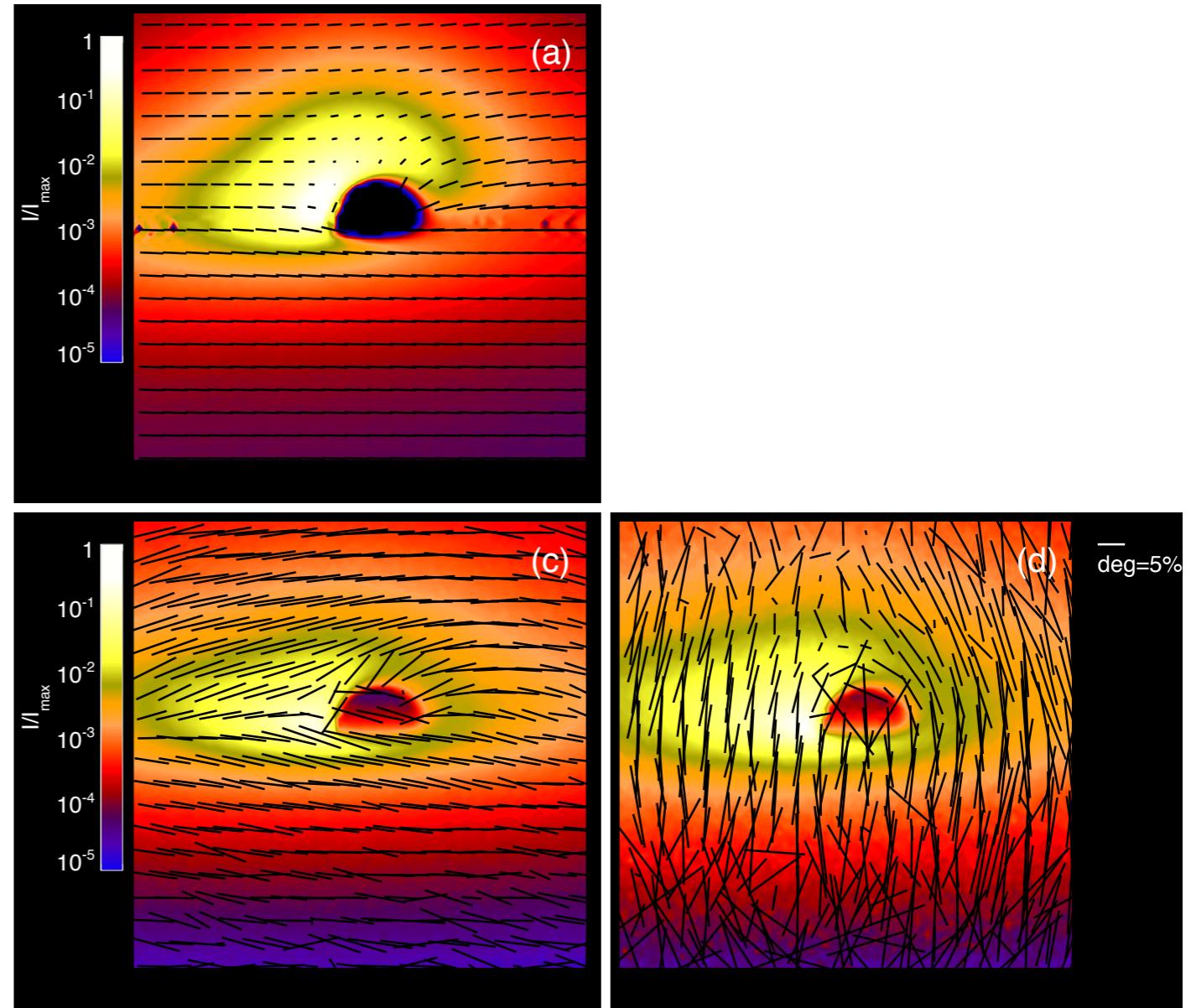
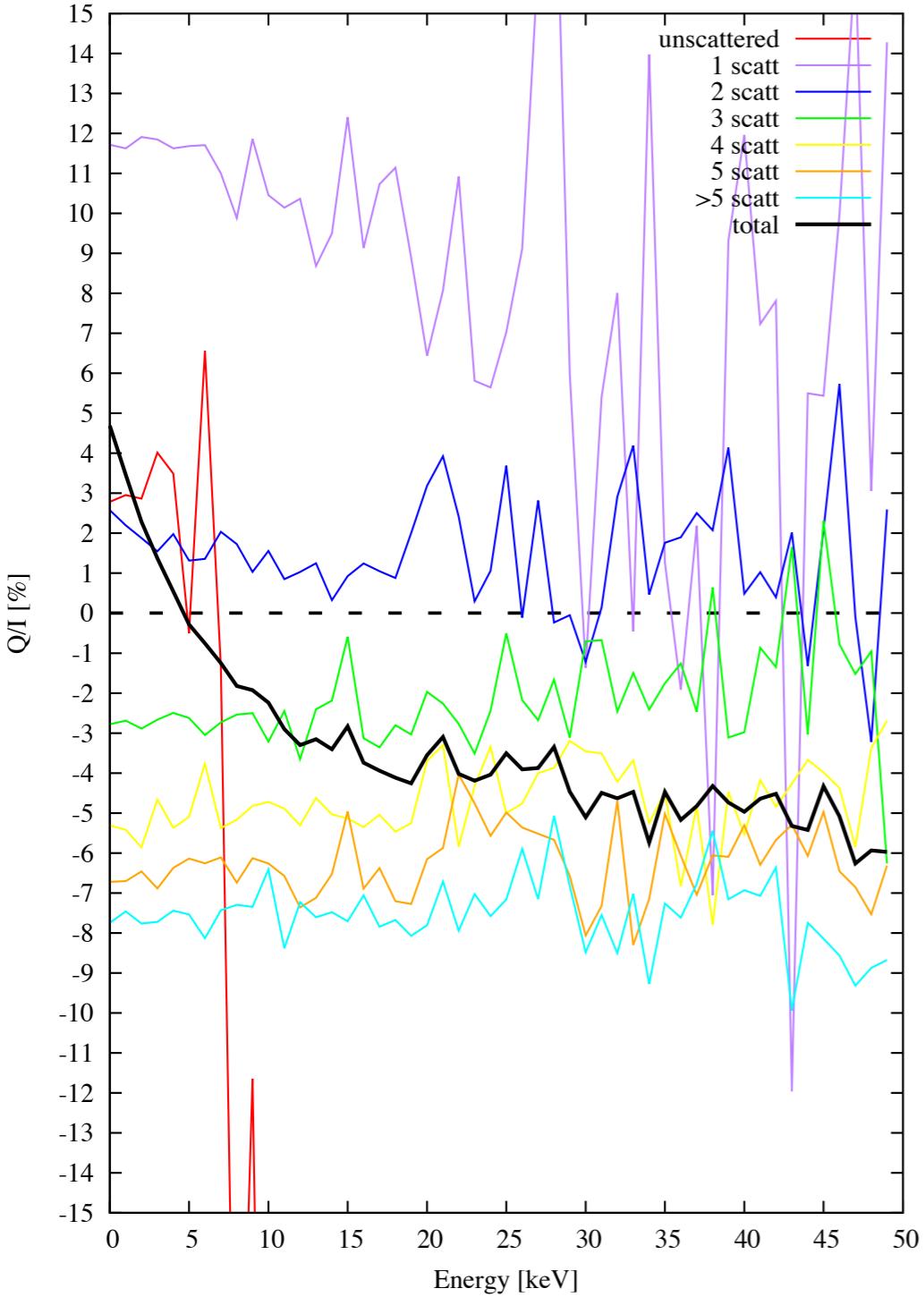
Schnittman-Krolik 09



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BHB LIMB SLAB tau = 1, kT = 100 keV

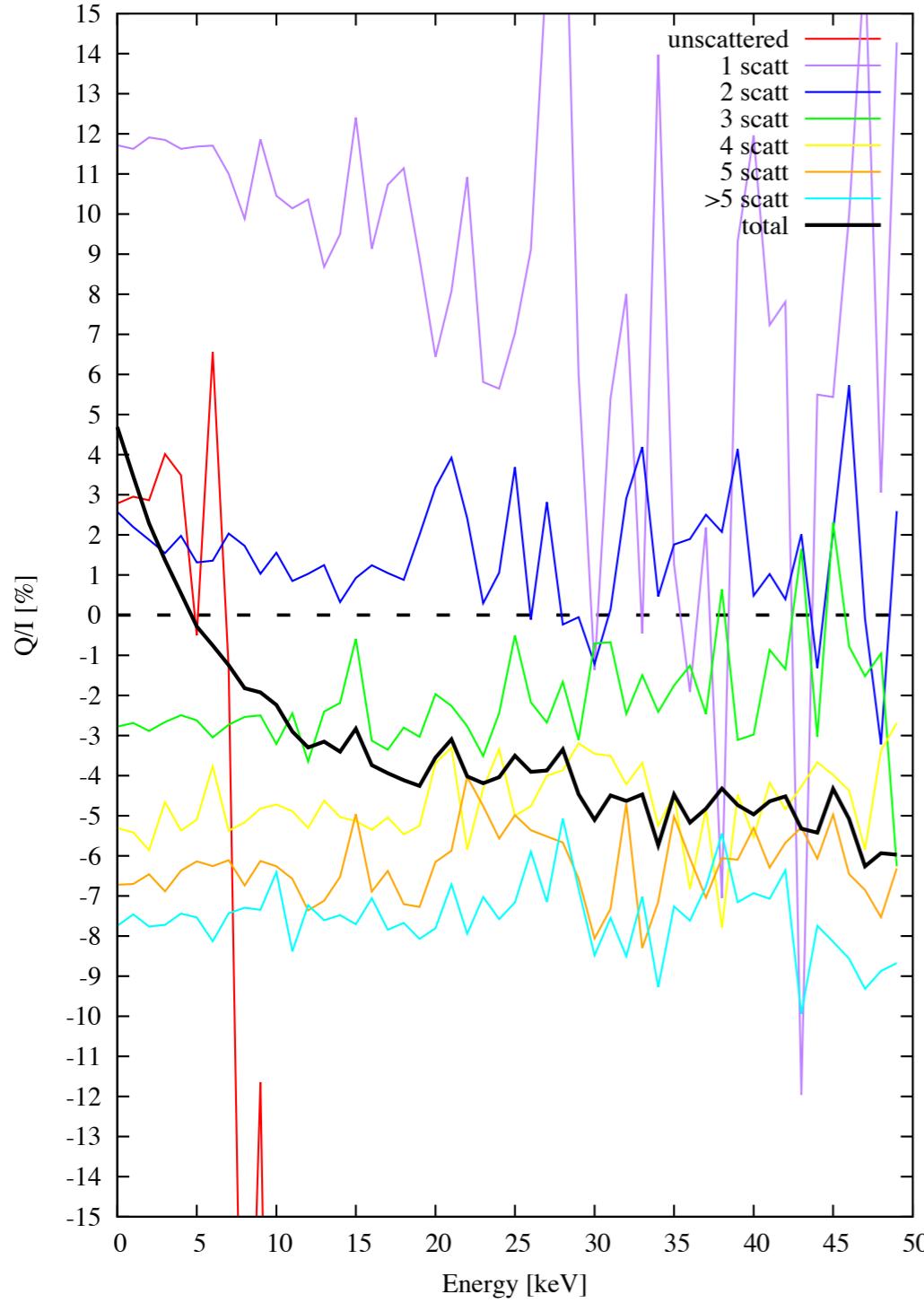
Q/I % multi AOV=60-90 (disc 6-500, mdot1, MBH 10Msun) SLAB LIMB tau1 kT 100 - 50 bins



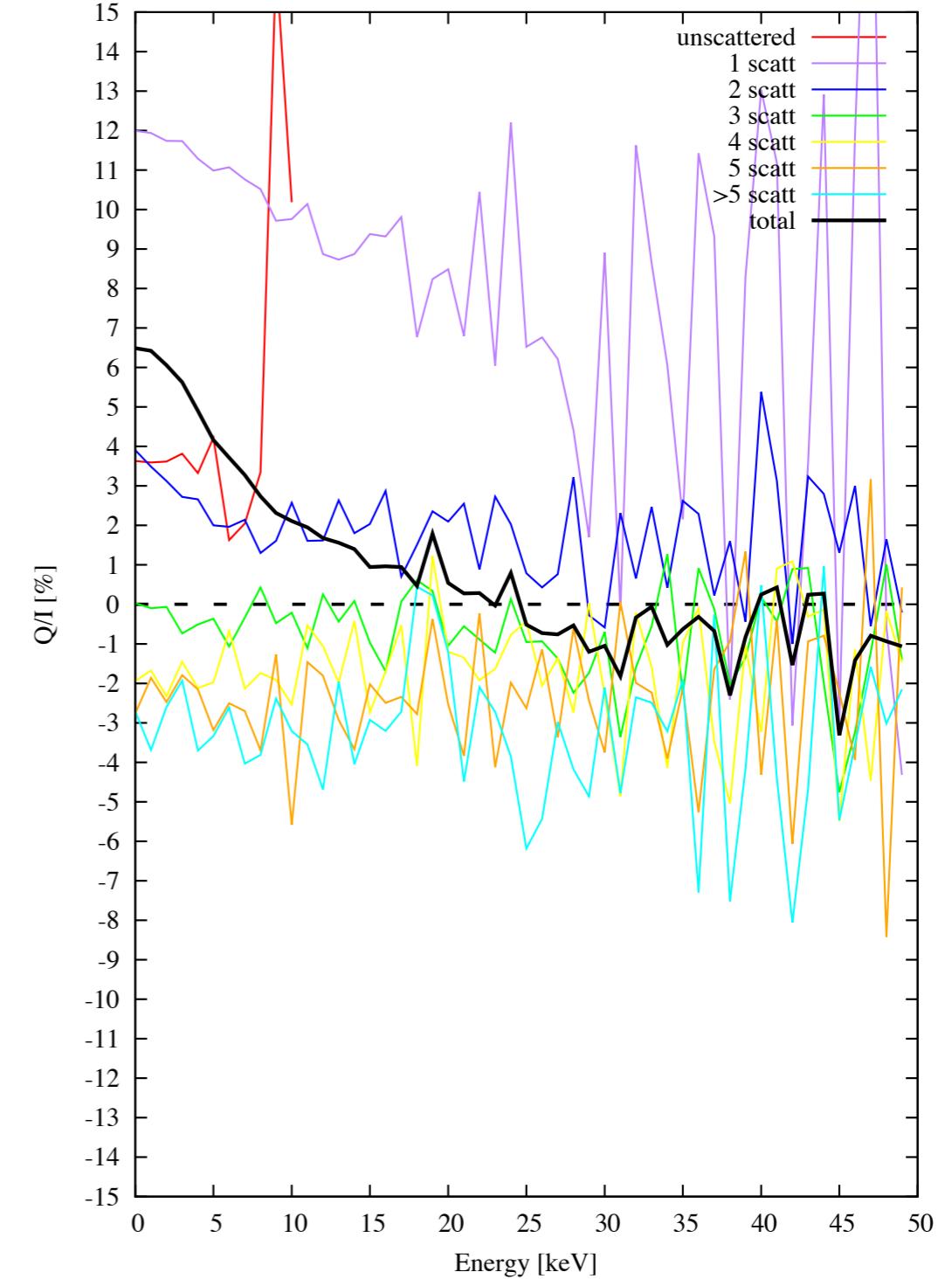
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BHB LIMB SLAB tau = 1, kT = 100 keV BHB LIMB SPHERE tau = 1, kT = 100 keV

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For both AGN and BHs the polarisation in the case of spherical corona do not exceed ~3% while for the slab it is ~7-8%
(see Alessia Tortosa et al. poster on NuStar sources!)

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For BHs we can even see if the **accretion disc** is optically thick or not (by observing limb darkening polarisation) and, if it is the case and we are lucky enough to see the tilt in the PA, we can infer even more information on the disc (i.g. if it is truncated or it extends up to the ISCO).

And all of this was just for $\tau = 1$!

Xipe Totec

"Our Lord the Skinned One", life-death-rebirth aztec deity, god of agriculture and many other things.

He gave his skin to nourish humanity, symbolising the corn seed which loses its outer layer in order to sprout.



Xipe Totec

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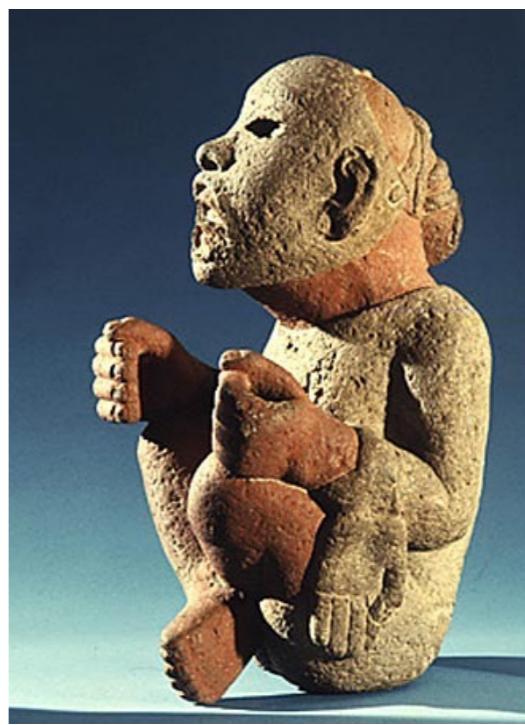
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