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

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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

1000 x tau

SPHERE

tau
### source parameters

- MBH = 10 Msun
- $\dot{m} = 0.1$ (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

corona parameters

kT = 100 keV

geometry SLAB/SPHERE
tau = 0.5/1/2
X-ray pol is complex
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Polarization Angle [deg]

Polarization Degree [%]
X-ray pol is complex

Pol Degree ($a00, \text{mdot01, MBH10}$) 10-1000 $\tau_1$ $kT_{100}$ - limb

Pol Angle ($a00, \text{mdot01, MBH10}$) 10-1000 $\tau_1$ $kT_{100}$ - limb

Polarization Angle [deg]

Polarization Degree [%]

Energy [keV]
Polarization angle [deg] vs Energy [keV]

Pol Degree (a00, mdot01, MBH10 ) 10-1000 tau1 kT100 - limb

Energy [keV] vs Polarization Degree [%]

Pol Angle (a00, mdot01, MBH10 ) 10-1000 tau1 kT100 - limb

Energy [keV] vs Polarization angle [deg]
SPHERE a0 - tau 05/1/2 - limb ON/OFF

Pol Degree (a00, mdot01, MBH1e7 ) 1000-1000 kT100 - 75 deg

Pol Angle (a00, mdot01, MBH1e7 ) 1000-1000 kT100 - 75 deg

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

Pol Degree (a09980, mdot01, MBH10 ) 1000-1000 kT100 - 75 deg

Pol Angle (a09980, mdot01, MBH10 ) 1000-1000 kT100 - 75 deg
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)