On the importance of X-ray polarimetry

diagnosis of the iron Kα broadening mechanism in AGN and BHXRB

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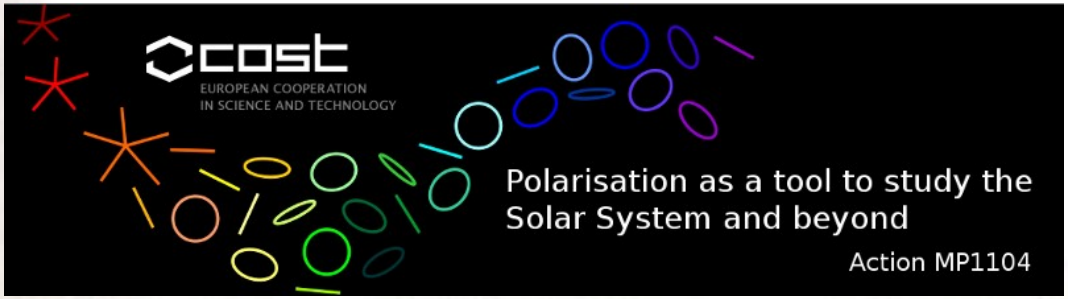
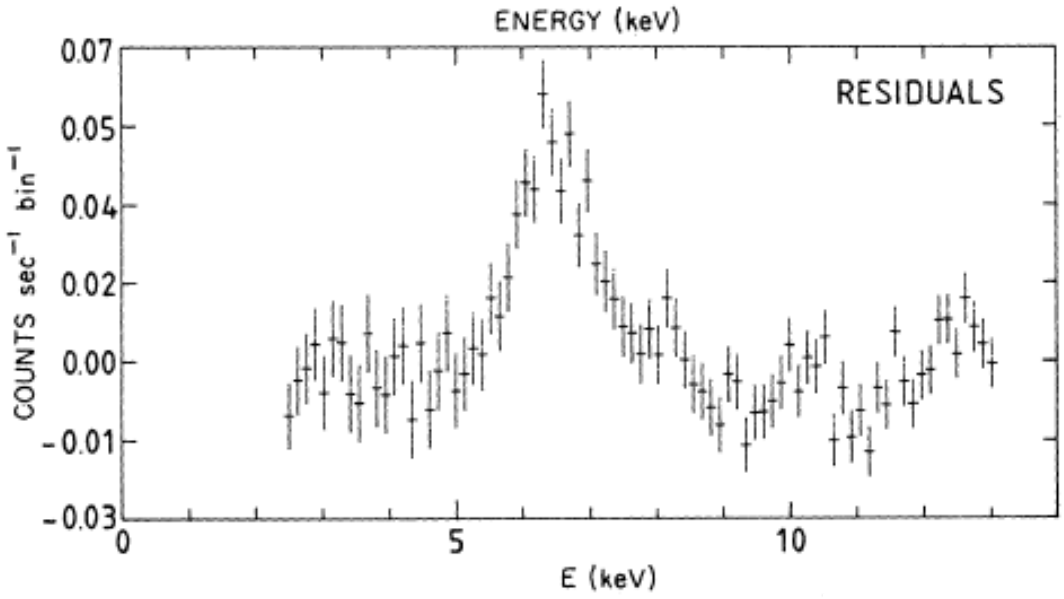


cnrs
dépasser les frontières

AGENCE NATIONALE DE LA RECHERCHE
ANR

Detection of broad iron Fe Kα lines



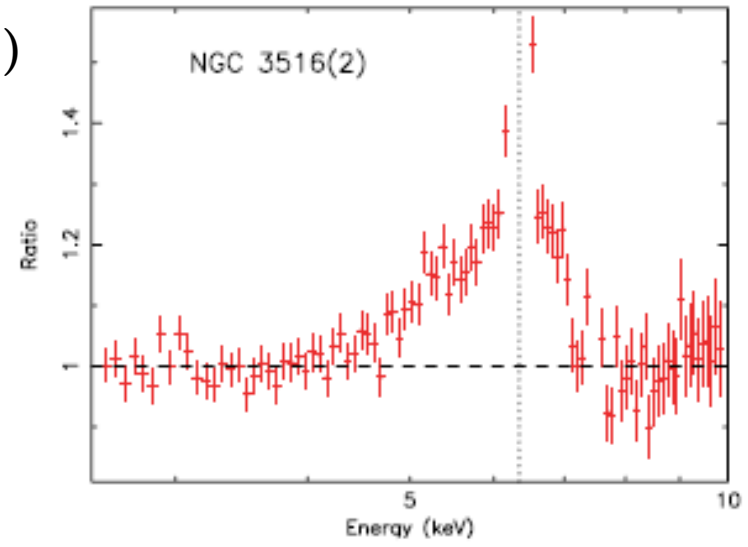
Cyg-X1 : first broad iron line discovered (Barr et al. 1985)

AGN survey by Pounds et al. (1990)

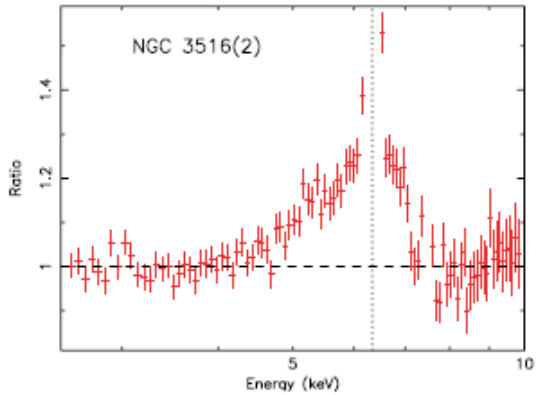
Asymmetrical distortion in Seyfert-1 AGN : extended red-wing (Reeves et al. 2006, ...)

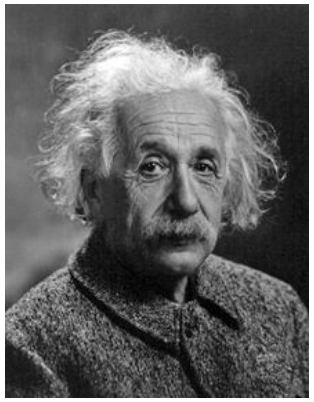
Fe broadening : Detection OK
Origin ?

Nandra et al. (2007)

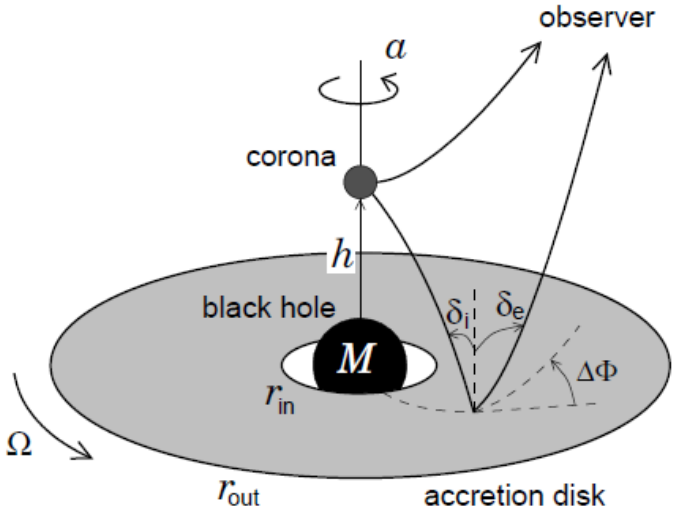


What do we see ?





General relativity effects



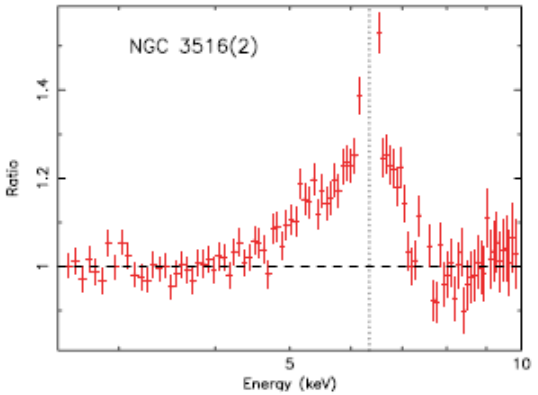
Dovciak et al. (2004)

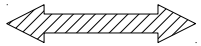
Reflected and reprocessed X-rays emission (accretion disk reaching down to the ISCO)

GR + Doppler effects blurring the line centroid

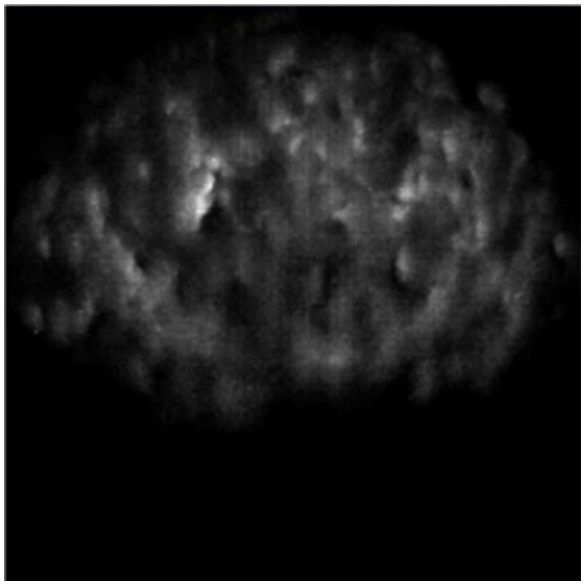
If disc and irradiation truncated at ISCO → BH spin constraints

What do we see ?





Complex, distant absorption



Credits : L. Turner

Cloud distribution at large distances, partially covering the irradiation source

Complex absorption and transmission through the gas are carving out the iron line red-wing

BH spin less related

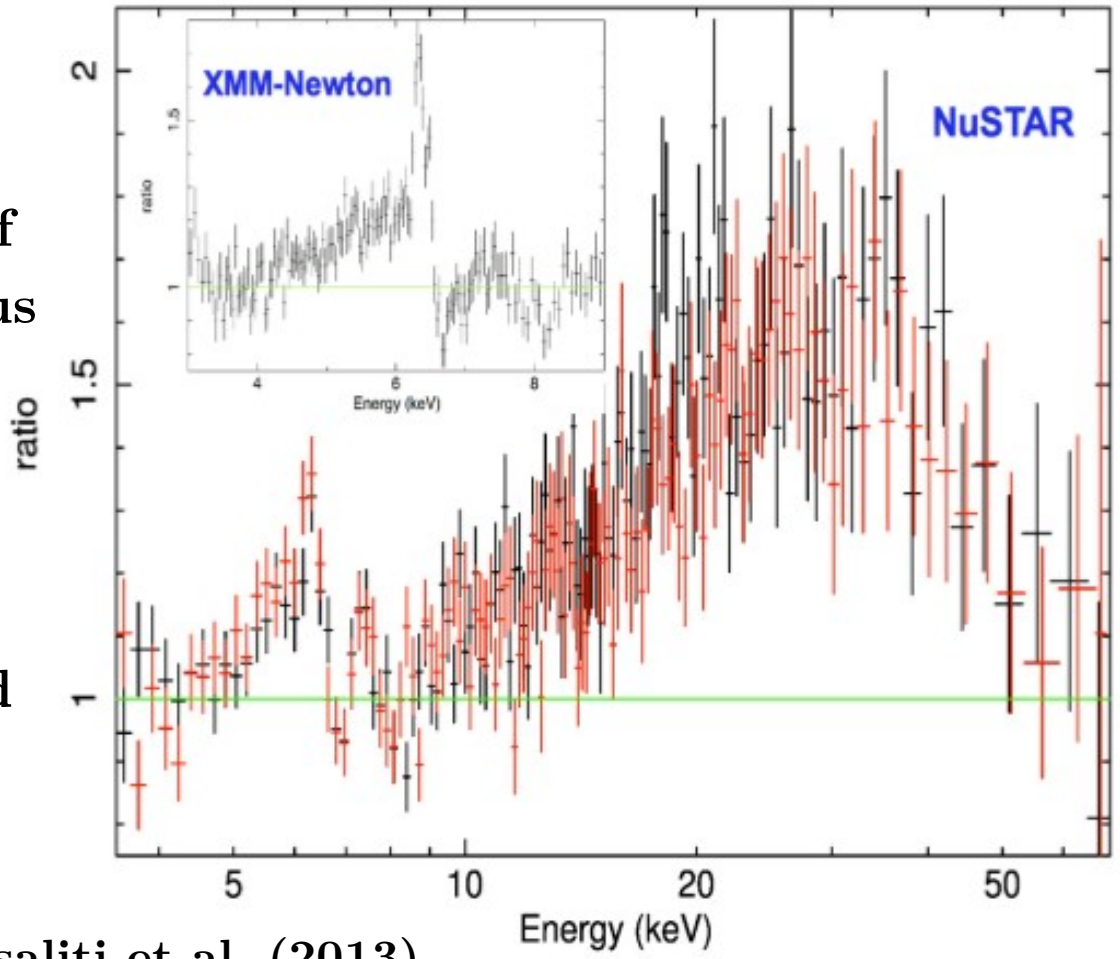
Another point of view : X-ray polarimetry

The new generation of X-ray satellites (NuSTAR, Astro-H) may shed more light on the correct scenario

But, despite the recent NuSTAR observation of NGC 1365, no consensus has been found

Another, independent method has to be found

X-ray polarimetry



Risaliti et al. (2013)

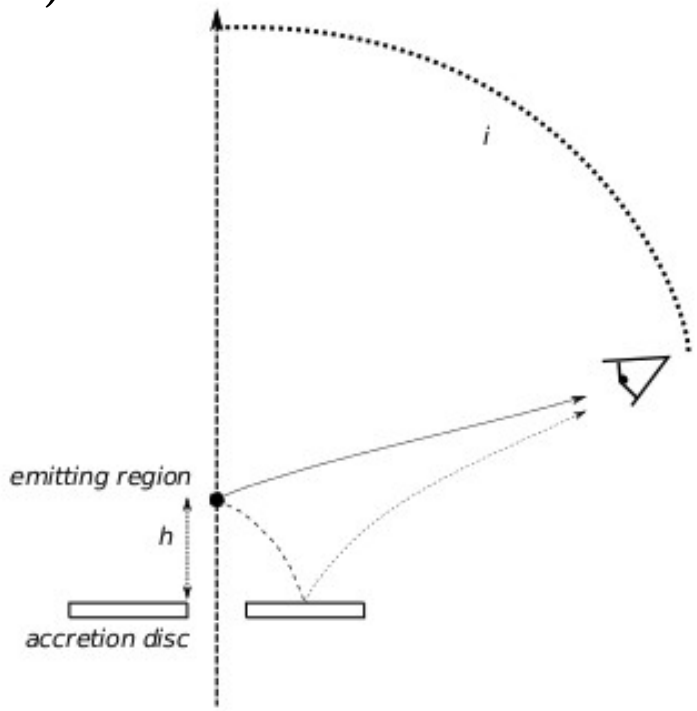
Investigating the two scenarios

Relativistic reflection (Miniutti & Fabian 2004, Risaliti et al. 2013)

Re-emitted radiation from a rotating accretion disk (NOAR, Dument et al. 2000)

Single scattering approximation (Chandrasekhar 1960)

Relativistic ray tracing (Dovciak et al. 2004)



Lamppost geometry

Kerr BH

Investigating the two scenarios

Complex absorption (Miller et al. 2008,2009,2013)

Cloud distribution around a central, irradiating slab

→ partial covering

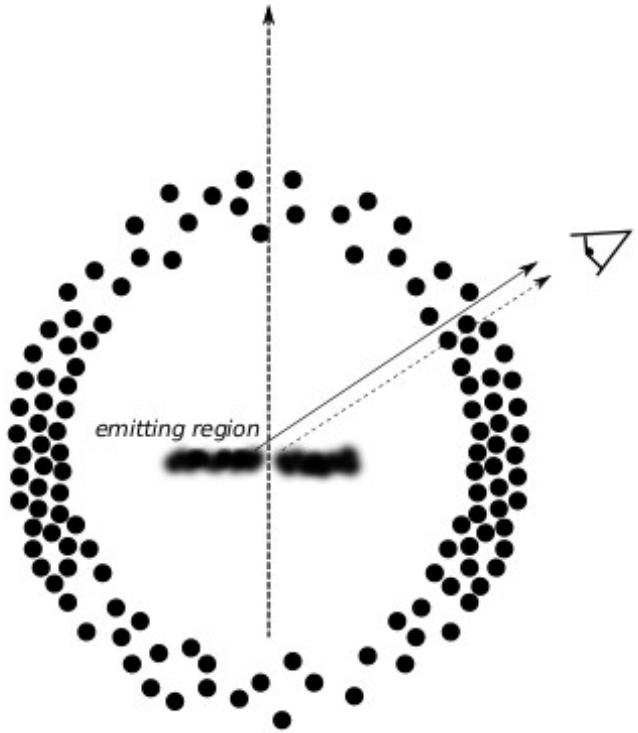
→ Compton thick, cold gas

Radiative transfer, polarization
and multiple scattering
(talk by René Goosmann)

STOKES

(Goosmann & Gaskell 2007)

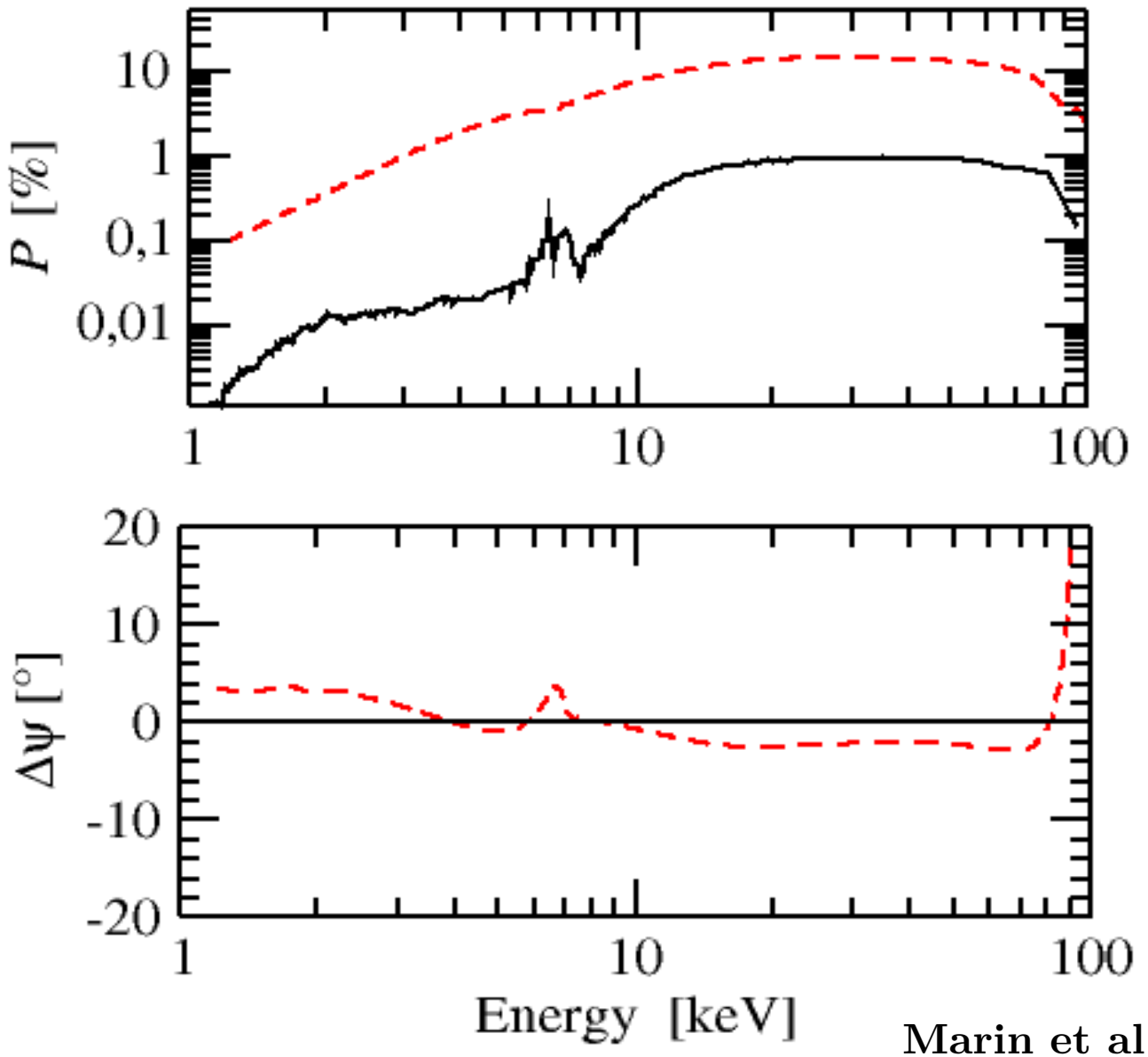
(Marin et al. 2012a)



Polarization results : MCG-6-30-15

Red : relativistic reflection (Miniutti & Fabian 2004)

Black : complex absorption (Miller et al. 2008,2009)

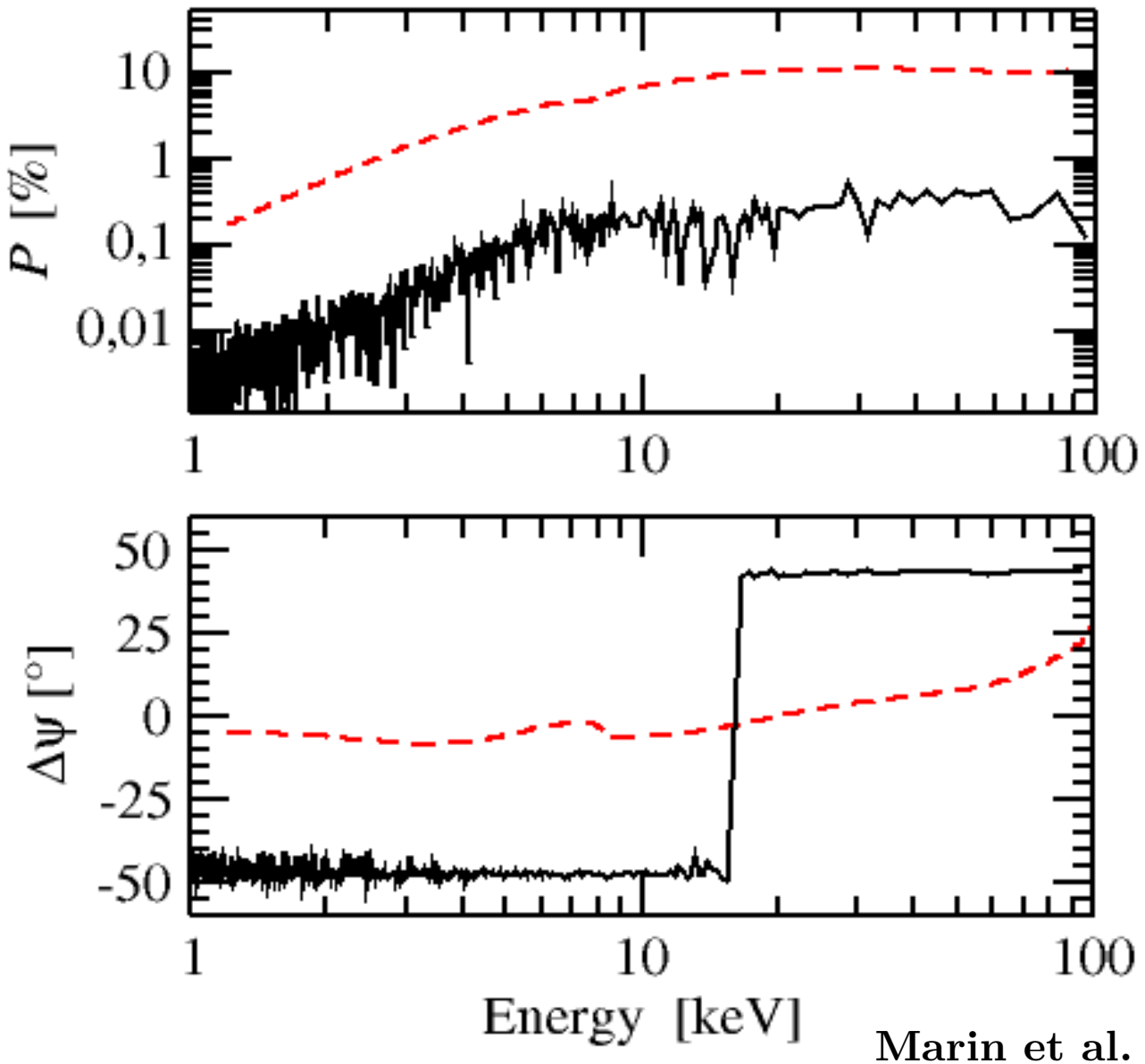


Marin et al. (2012b)

Polarization results : NGC 1365

Red : relativistic reflection (Risaliti et al. 2013)

Black : complex absorption (Miller & Turner 2013)



Marin et al. (submitted)

Are polarimetric measurements realistic ?

Sadly, no flying X-ray polarimeter ...

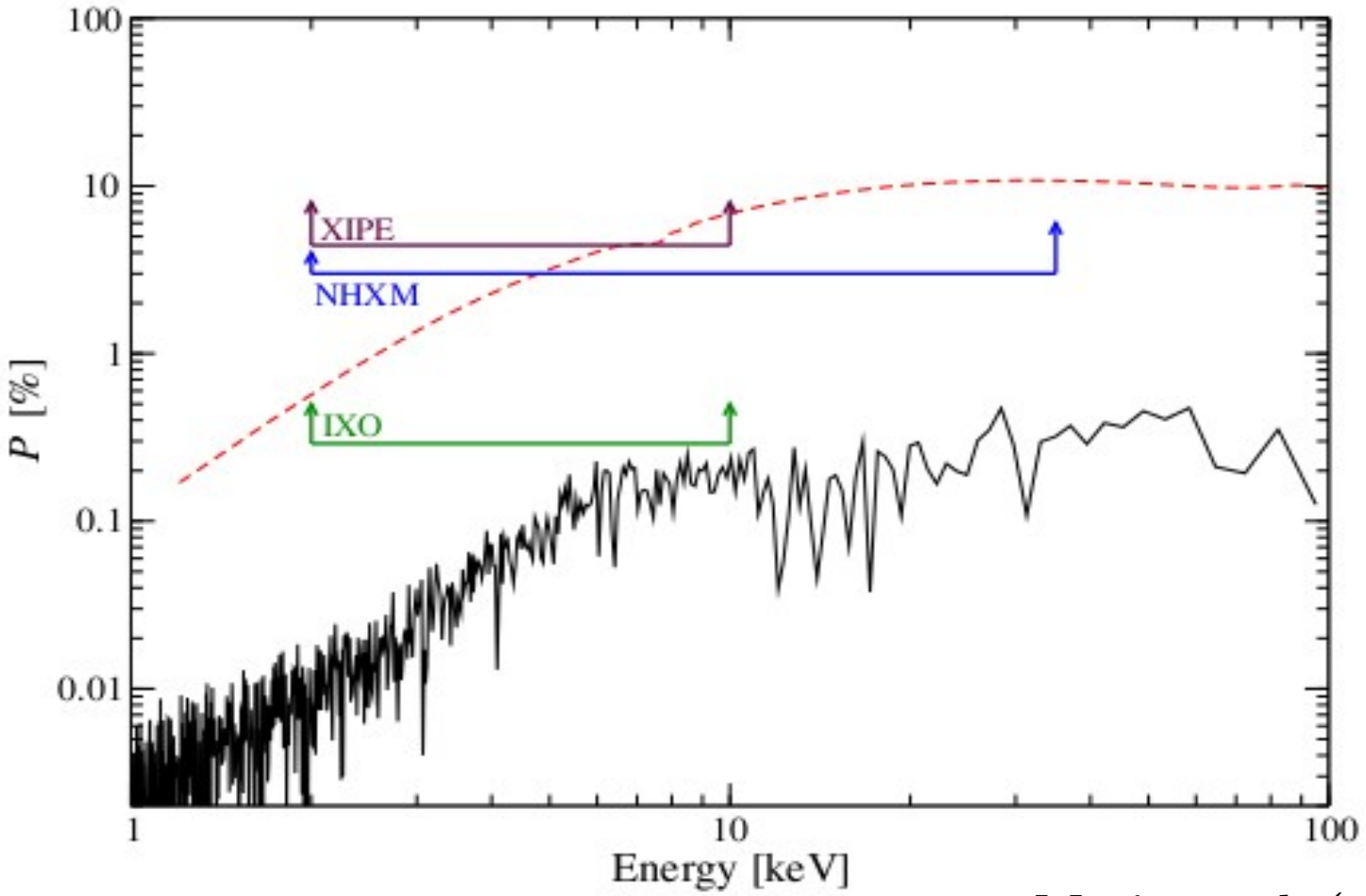
What past, unselected missions could have detected ?
The case of IXO, NHXM and XIPE

Gas Pixel Detector (Bellazzini et al. 2006; Bellazzini & Muleri 2010)

MCG-6-30-15 flux : ~ 3 mCrab (2 – 10 keV band)
NGC 1365 flux : ~ 1 mCrab (2 – 10 keV band)
~ 2,6 mCrab (17 – 60 keV band)

Observation time : 1 Ms
Background noise : 1μCrab

Minimum detectable polarization



Marin et al. (submitted)

NGC 1365

Red : relativistic reflection

Black : complex absorption

Conclusions

Relativistic reflection and complex absorption scenarios are different in polarization !

P and ψ as two new and independent constraints from spectroscopic and timing analyses

- **significant P level : reflection**
- **no P detection : absorption**
- **smooth variation of ψ : reflection**
- **no ψ variation or ⊥ switch : absorption**

X-ray polarimetry can distinguish
Broadband polarimeter strongly recommended