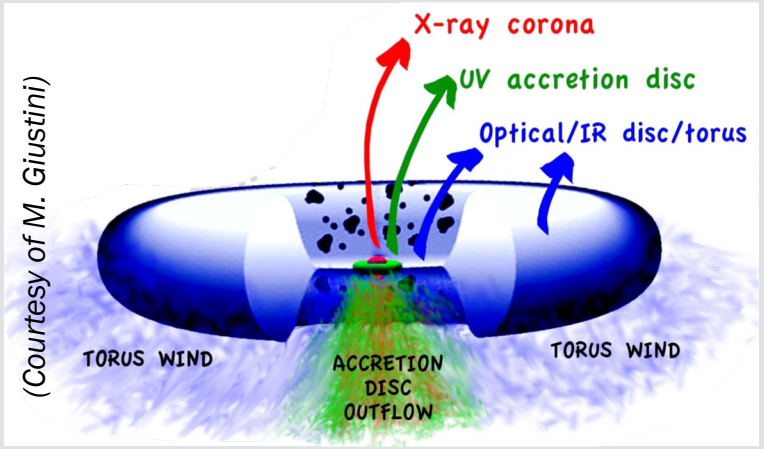
THE UV-X-RAY HIGH-RESOLUTION VIEW OF OUTFLOWING WINDS IN AGN: THE CASE OF I ZWICKY 1

E. Costantini (SRON)

outflow taxonomy



All kind of winds can coexist in the same AGN

Galactic WA
R=kpc

...

WA
V=100-1000 km/s
R=pc

UV absorber
Line driven

Episodic mass Ejection
R=sub-pc
V=1000km/s

Ultra fast winds
V=0.1c
R=sub-pc

BH

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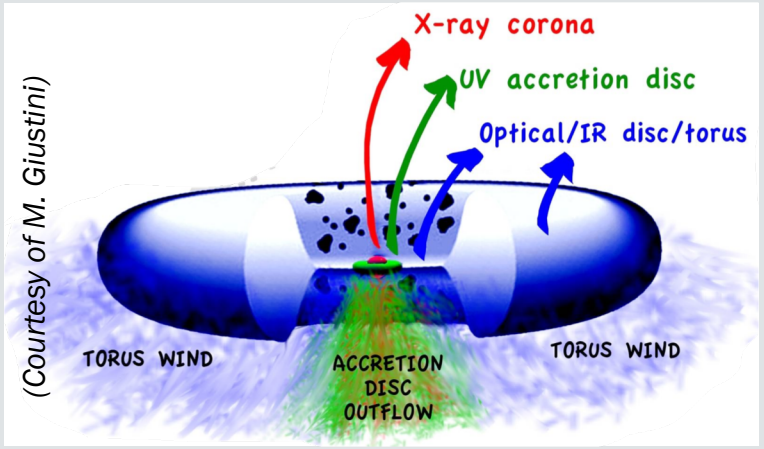

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(Talks by J. Kaastra A.L. Longinotti)

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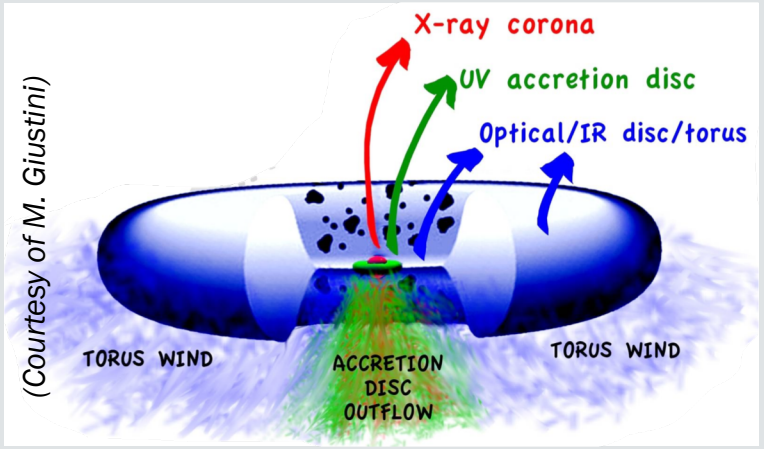

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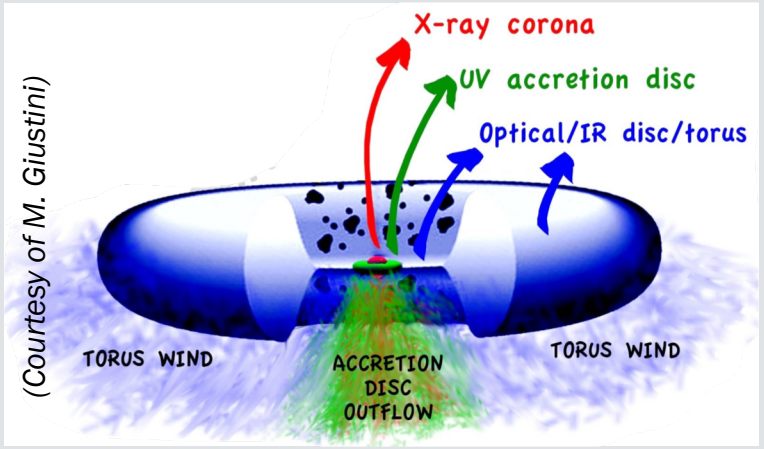

This talk

Galactic WA
R=kpc

(di Gesu, EC+14,18)

...

WA
V=100-1000 km/s
R=pc

UV absorber
Line driven

(EC+07, Silva, EC+ 2017, Giustinin,EC+in prep, Crenshaw+03, EC 10)

(Talk by J. Kaastra)

Episodic mass
Ejection
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(Talk by A.L. Longinotti)

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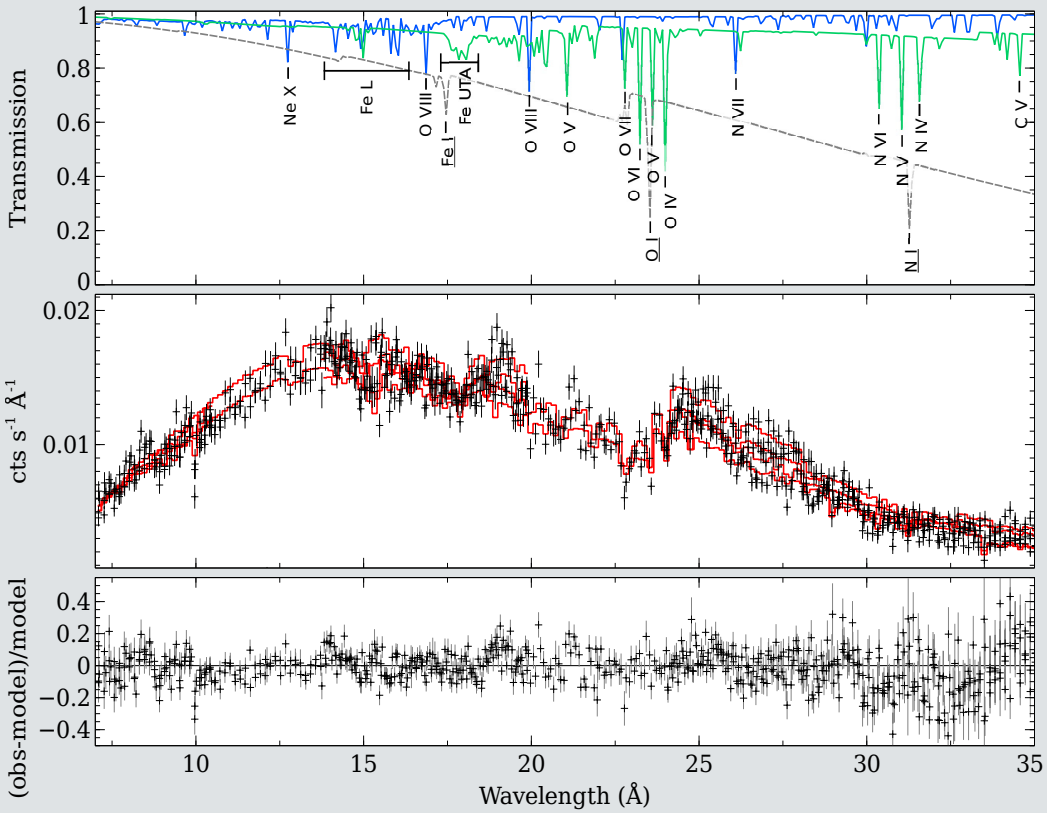
I Zw1:
simultaneous XMM (230 ks)+ HST (6 orbits) campaign carried out in 2015

- E. Costantini (PI) – SRON, UvA
- C. Silva – SRON, UvA
- G. Kriss – STSci
- L. Gallo – Univ. St. Mary
- D. Wilkins –-Stanford
- M. Giustini -- CAB
- W. Brandt – Penn State Univ.

The X-ray warm absorber

- 1 low ionization UV/X component has a velocity of ~2000 km/s
- 1 highly ionized component only seen in the X-rays (v_{out}~2000 km/s)



(Costantini+07, Silva, EC+18),

How does this relate to the UV absorber and past observations?

The HST data: kinematics

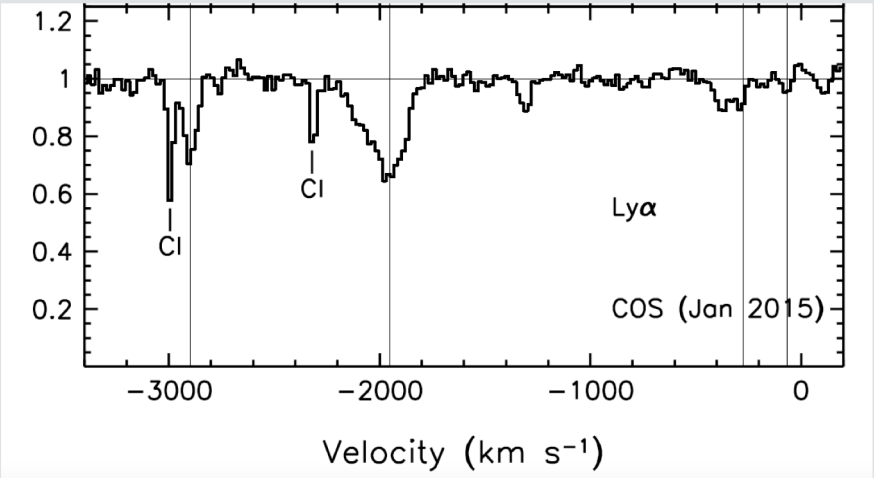
Long lived component at 2000 km/s
lasting at least between 1994 and 2015.

Kinematics and ionization agree with the RGS low-ionization component:

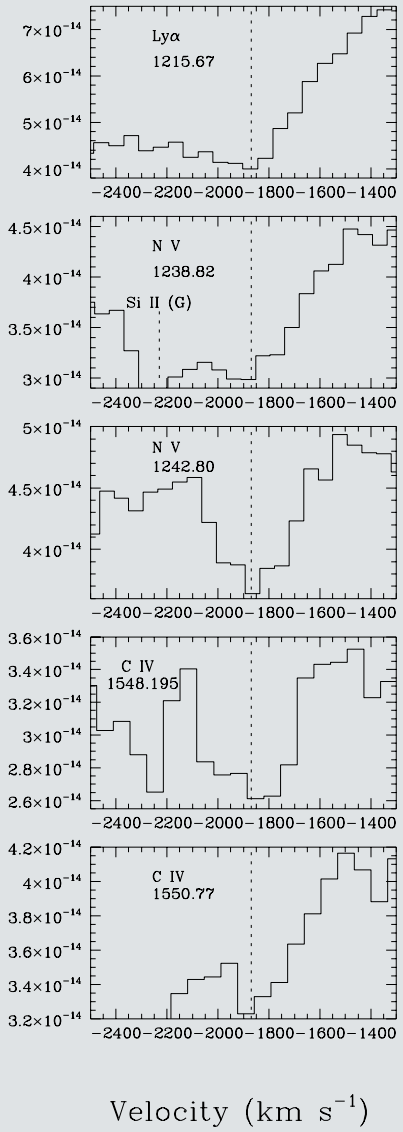
The UV/X-ray gas is one and the same gas!

(EC+07, Silva, EC+18)

HST-COS



HST-FOS



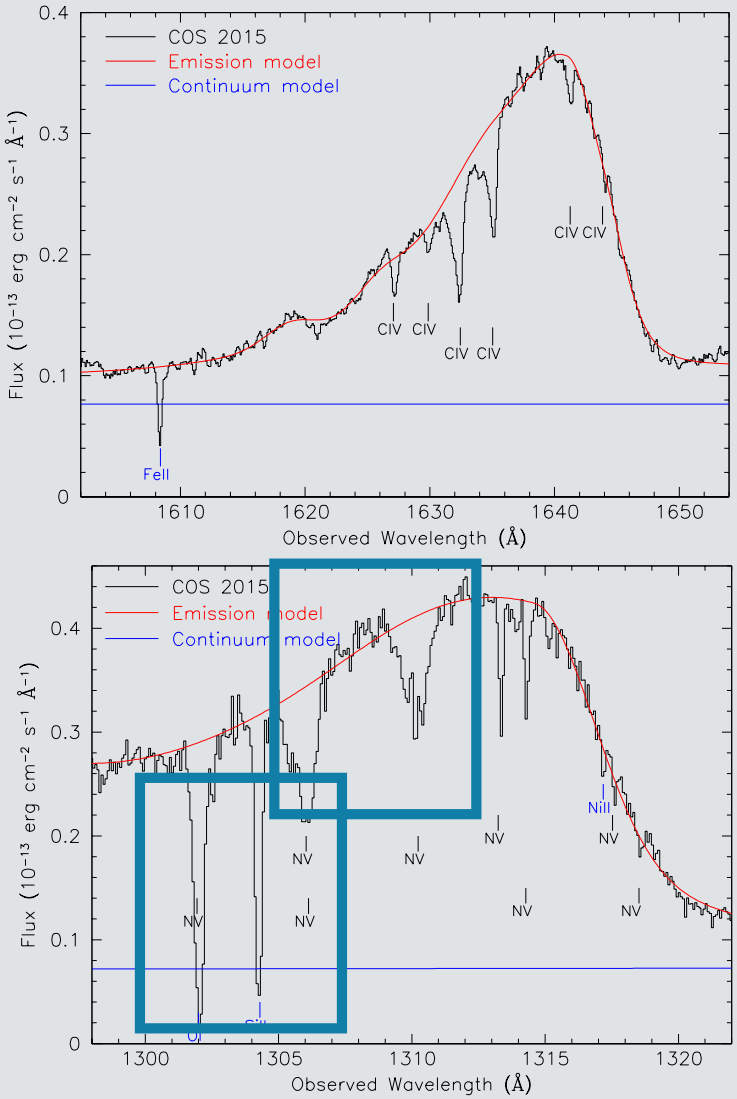
(1994, Laor+97)

The HST data: a radiation driven outflow

Line-locking is a common
feature of radiation driven UV outflows
(Weymann+97)

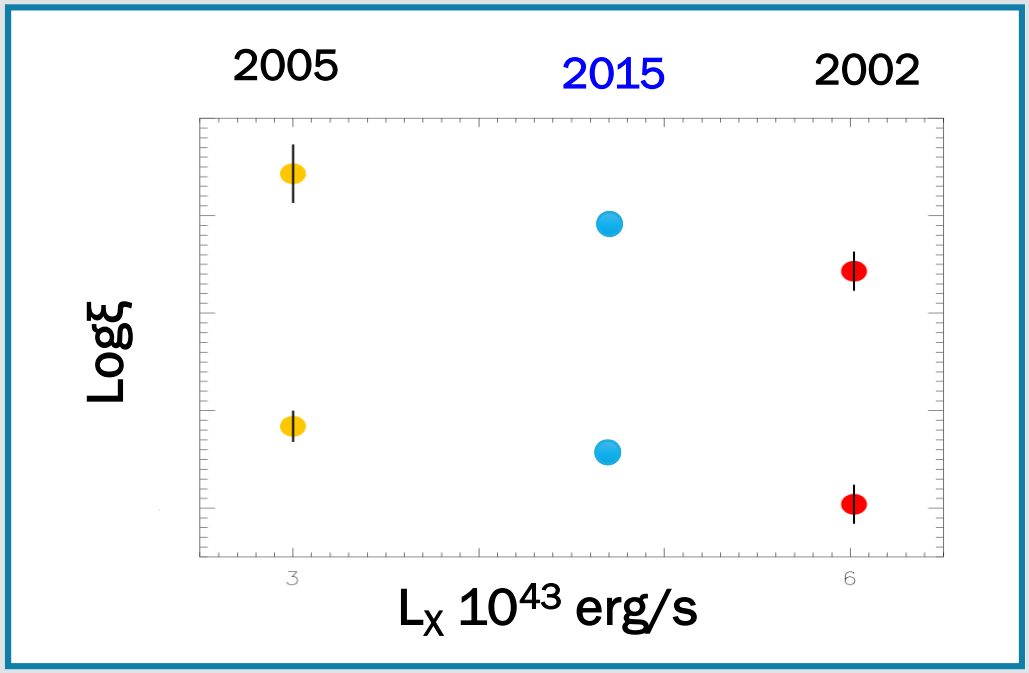
Line locking: the relative velocity of two gas
systems is regulated according to
their effective exposure to the source radiation field
with a minimum separation given by a doublet (NV)
(e.g. Milne 1926, Burbridge & Burbridge 75)

The UV-X-ray low-ξ gas is radiation driven



Long term variability of the multi-component UV-X-ray absorber

The warm absorber X-ray history

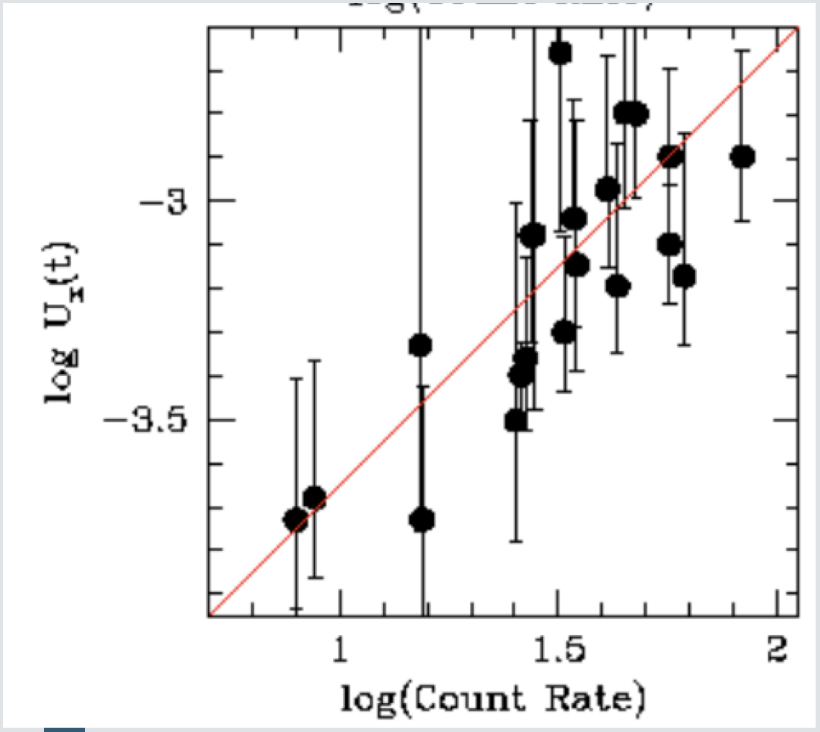


- Ionization changed (together for the two components)
- N_H changed (factor > 6)
- Also short term change in N_H, not related to L
- The components are NOT in pressure equilibrium

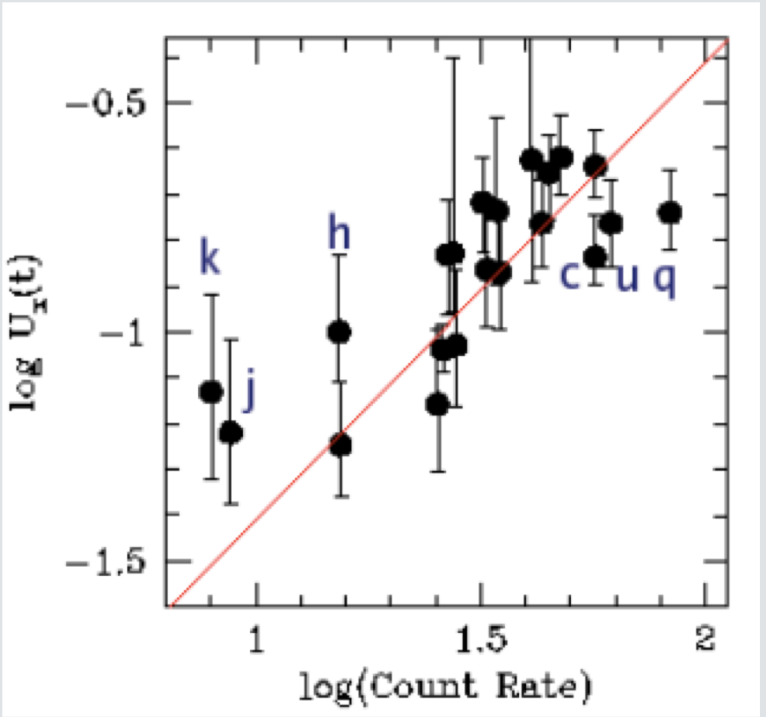
(Costantini+07, Silva, EC+ 18.)

Expectations: a classical WA

The gas reaches instantaneous equilibrium



The gas reaction is delayed before reaching equilibrium



(Krolik &Kriss 95, Krongold+07)

The classical view: a homogeneous, stratified medium

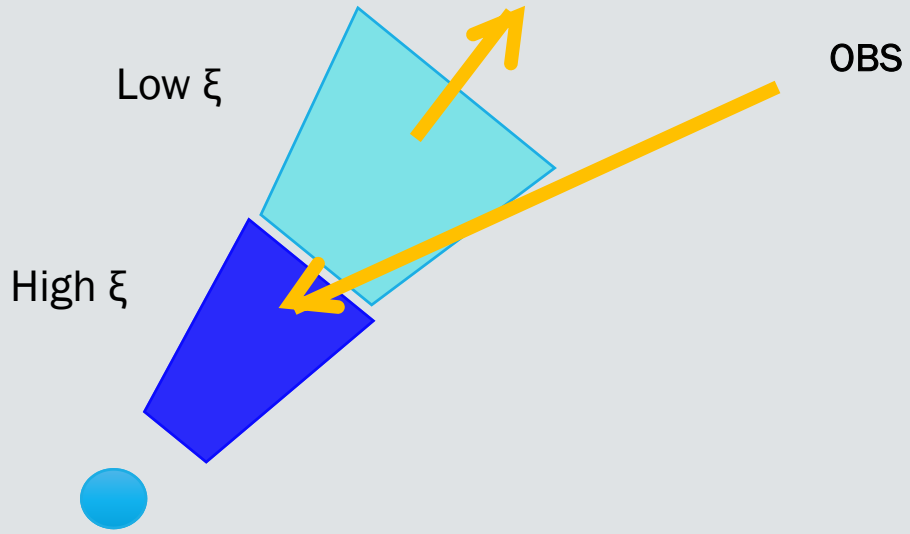
x Long term change in log ξ (not correlated with L)

→ invoke constant non equilibrium

x Short (and long term) change in N_H

→ no apparent reason ? (but see later)

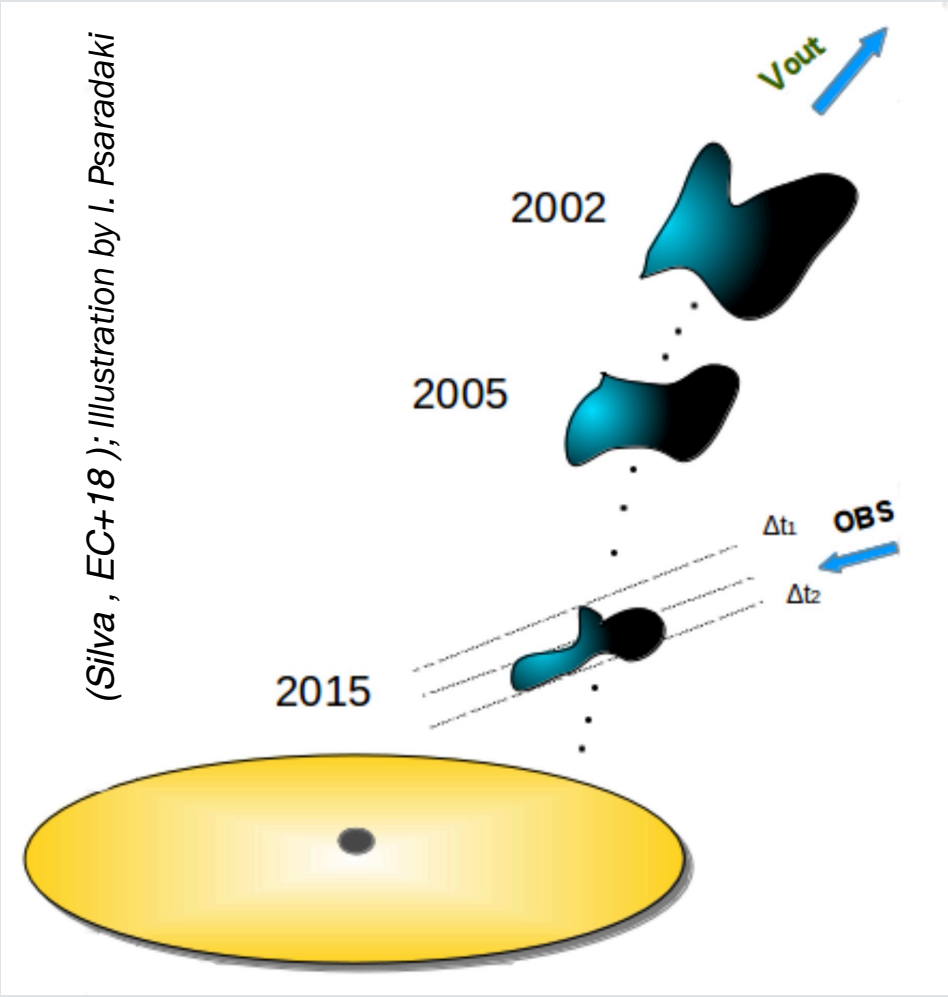
✓ Same velocity for the two components X-ray + 1 UV component



ORIGIN AND GEOMETRY OF THE OUTFLOW:
A STEAMING BOAT

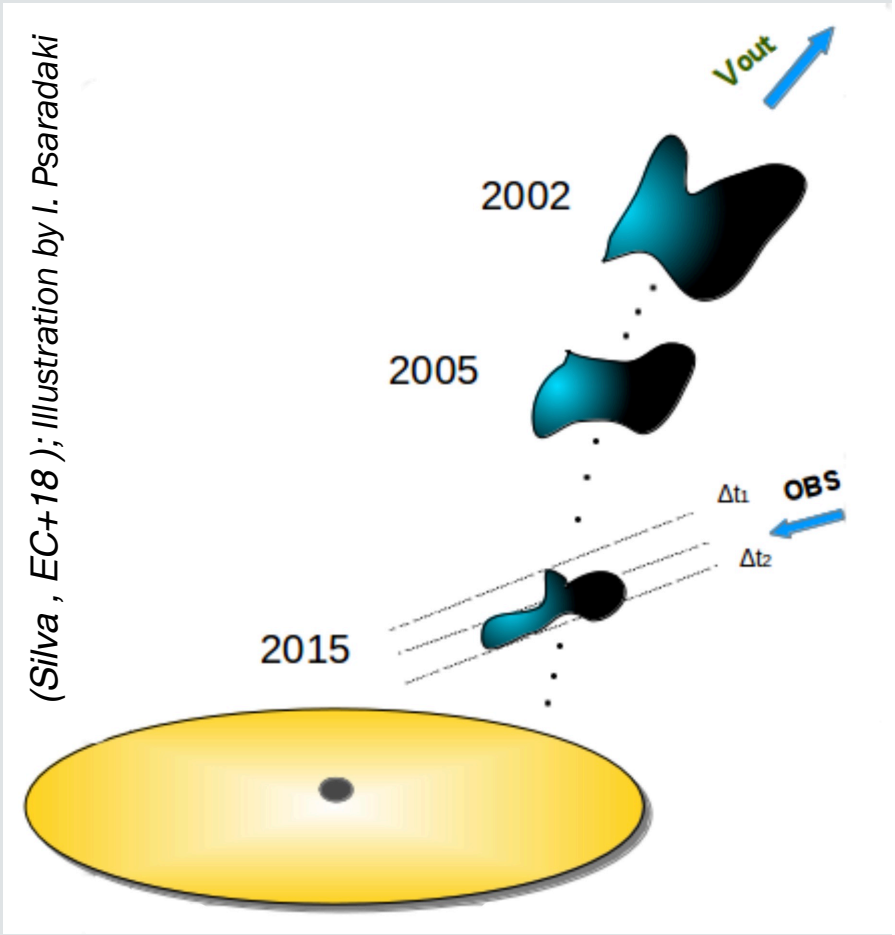
Clumpy outflow driven by radiation pressure

High and low ξ gas are two faces of the same gas



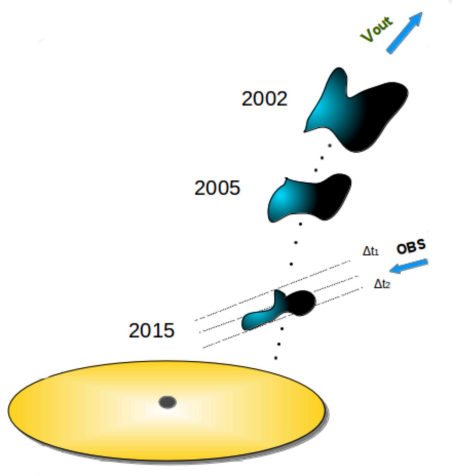
ORIGIN AND GEOMETRY OF THE OUTFLOW: A STEAMING BOAT

- ✓ No photoionization equilibrium
- ✓ Changes in opacity
- ✓ Ionization mainly depend on the density and not on the distance from the source
- ✓ No pressure equilibrium
- ✓ Components vary together
- ✓ Same velocity



(Silva , EC+18); Illustration by I. Psaradaki

Conclusions



- X-ray and UV observations are a powerful tool to understand any kind of highly ionized outflow
- For warm absorber it is essential to understand the density, geometry and launching mechanism of the outflow
- In the (lucky) case of I Zw1 we could establish the outflowing system with extraordinary clarity, thanks to the long term X-ray variability and the UV-X-ray campaign.