UNIVERSITY
OF AMSTERDAM

HIGH-RESOLUTION X-RAY SPECTROSCOPY OF THE INTERSTELLAR DUST

Daniele Rogantini

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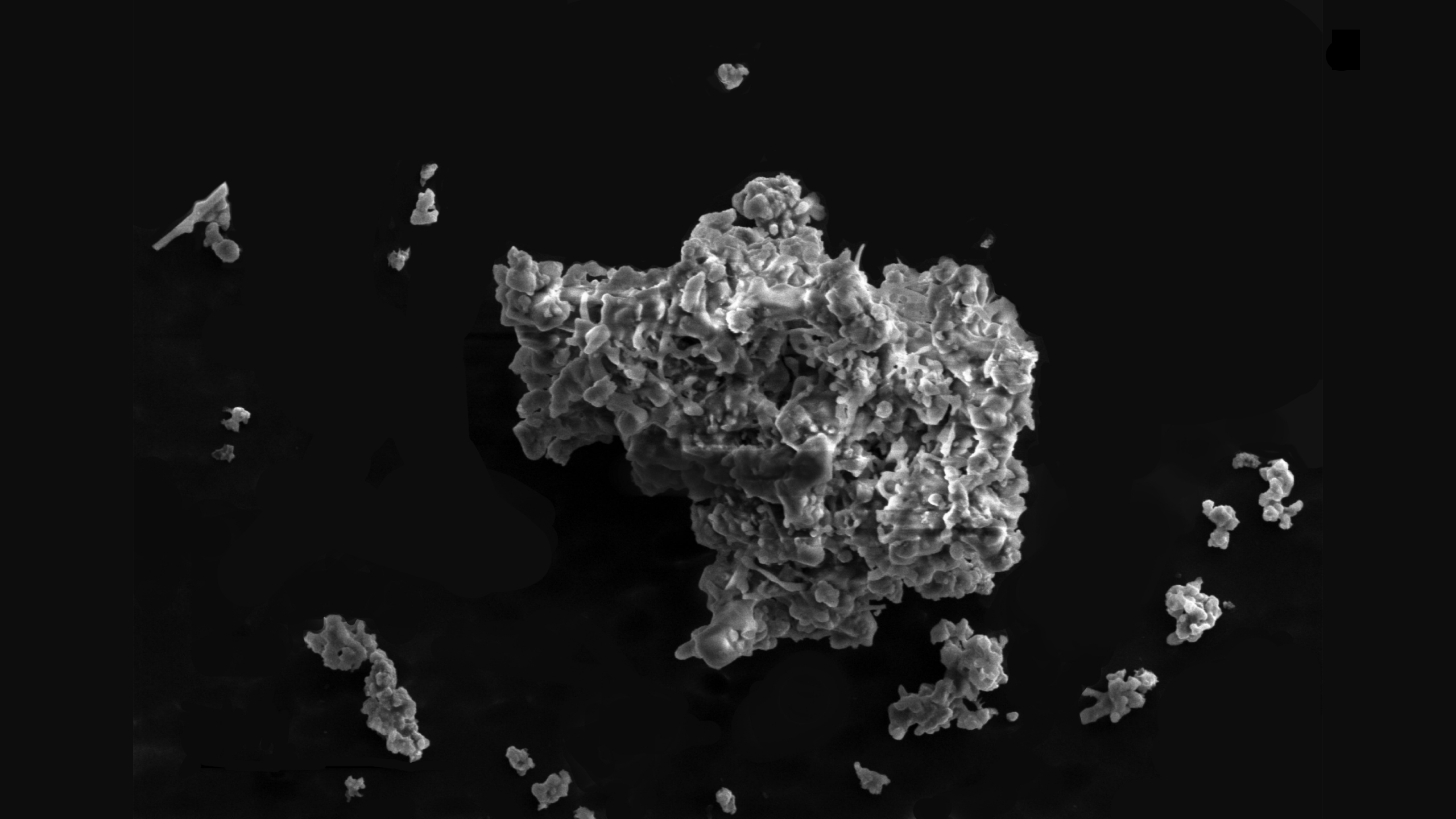
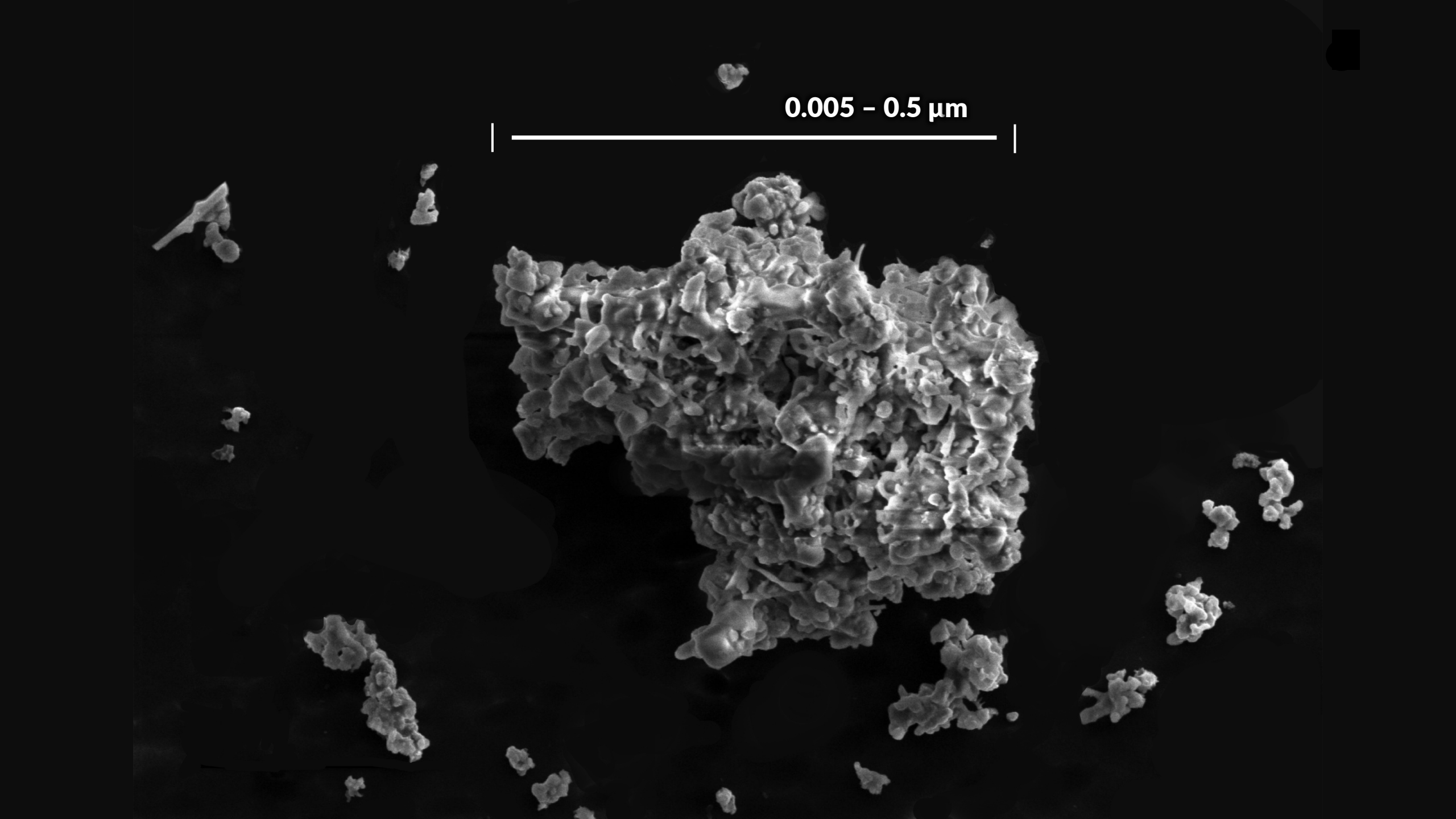
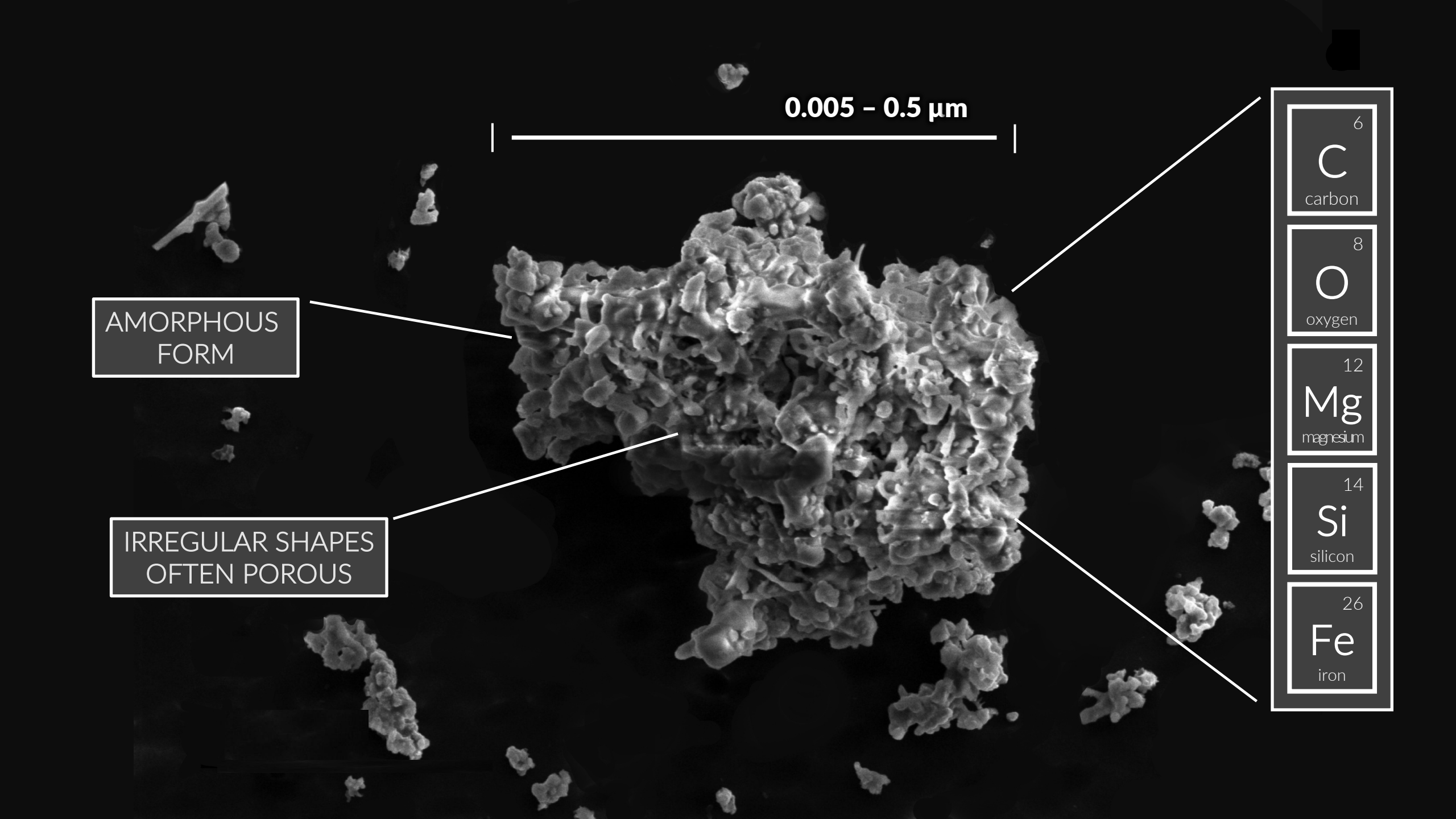
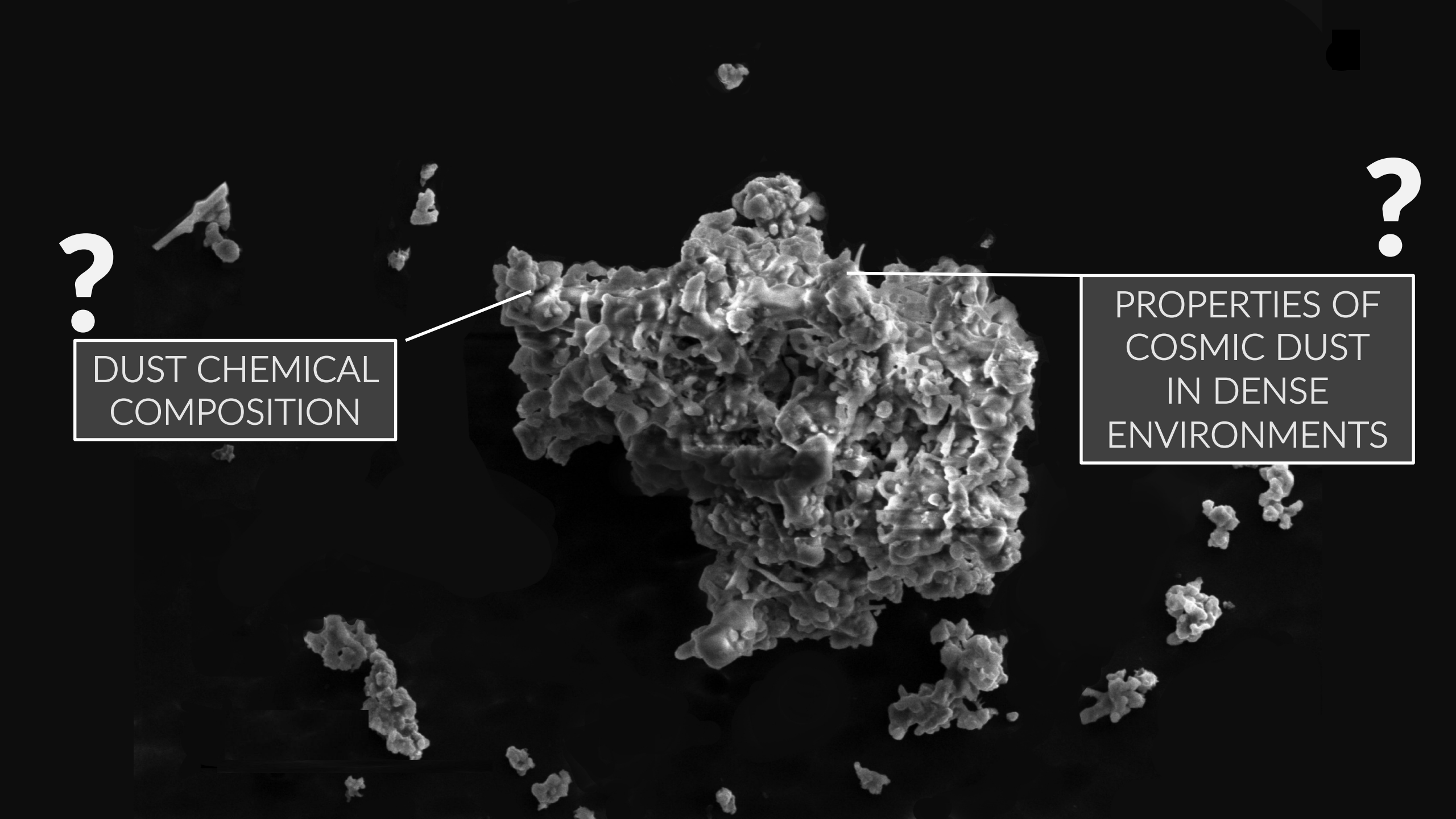
Missagh Mehdipour, Ioanna Psaradaki and Rens Waters.

SRON

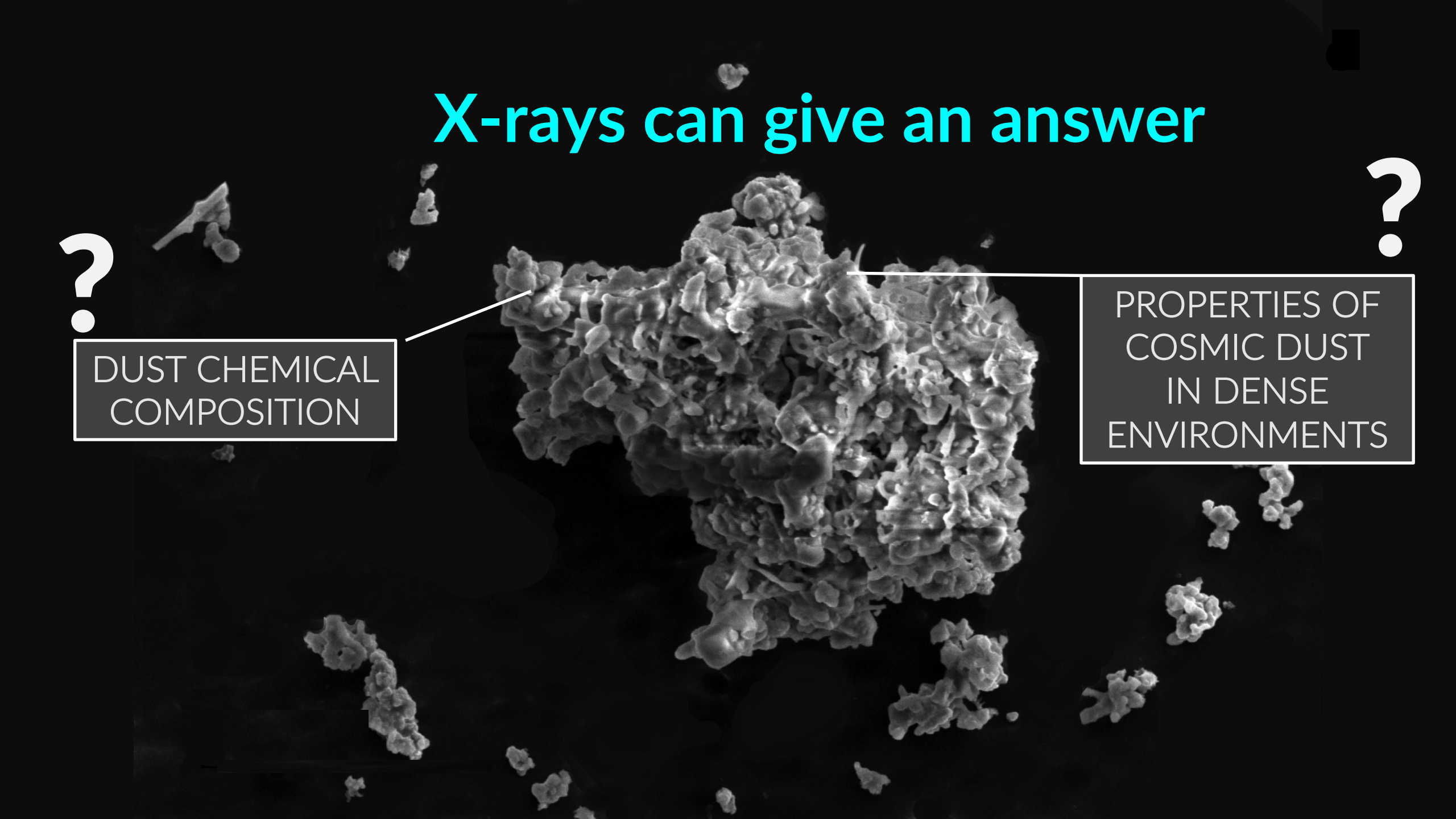


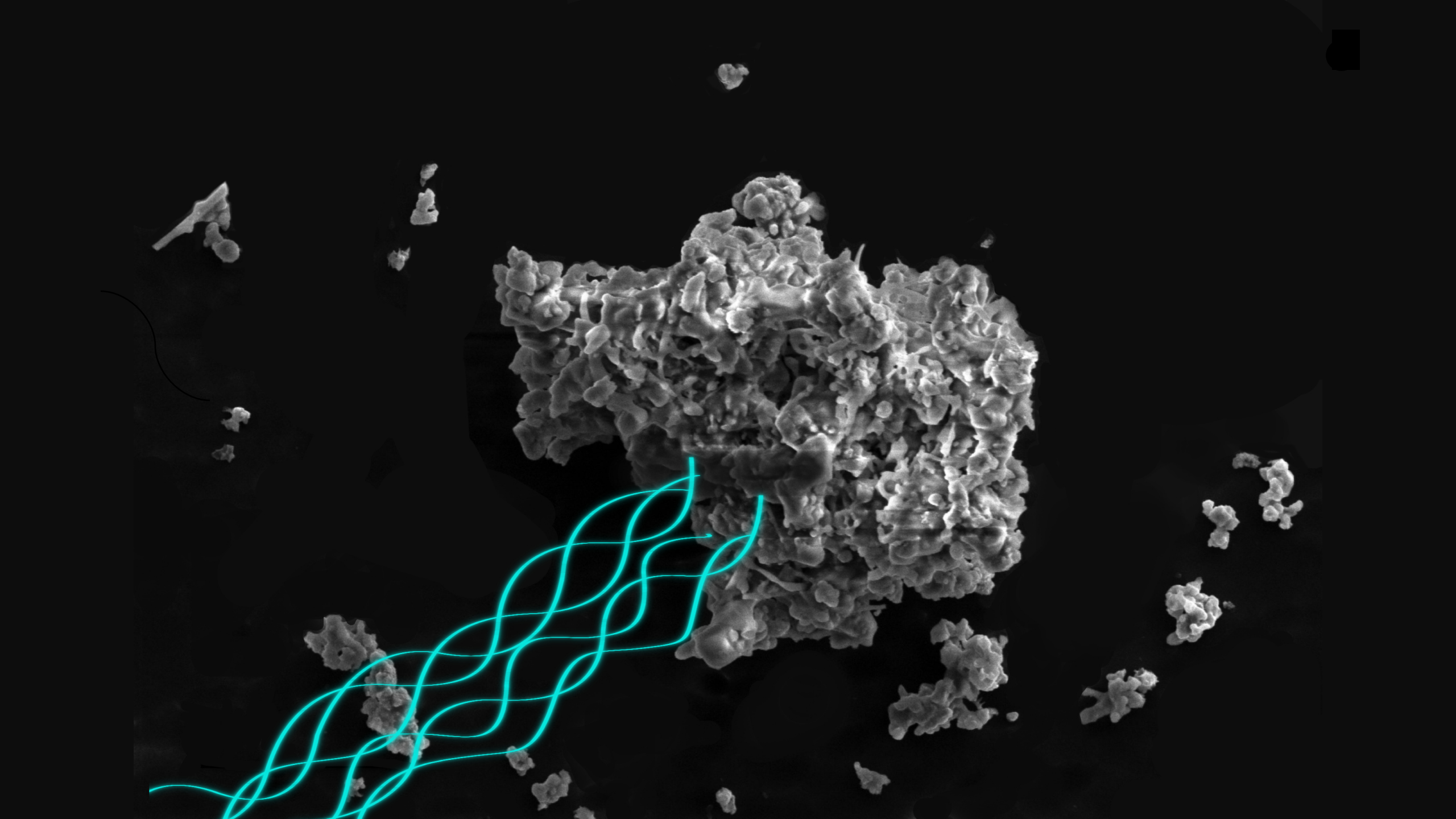

0.005 – 0.5 µm


0.005 – 0.5 µm
AMORPHOUS FORM
IRREGULAR SHAPES OFTEN POROUS
6
C
carbon
8
O
oxygen
12
Mg
magnesium
14
Si
silicon
26
Fe
iron


?
DUST CHEMICAL COMPOSITION
?
PROPERTIES OF COSMIC DUST IN DENSE ENVIRONMENTS

X-rays can give an answer



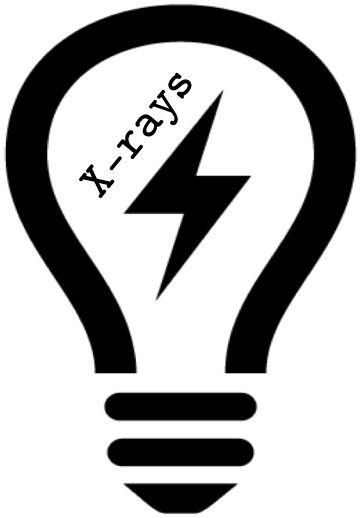


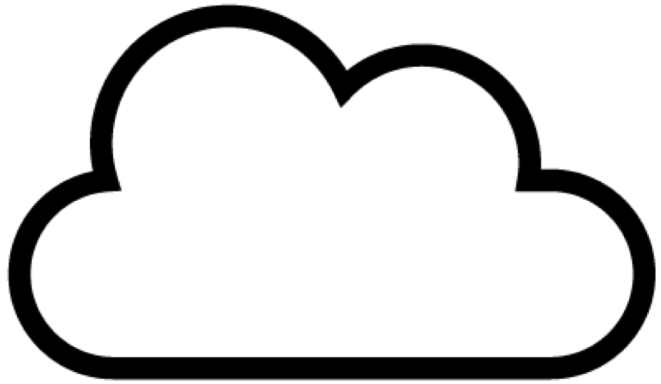
XAFS

X-RAY ABSORPTION FINE STRUCTURES

X-RAYING THE GALAXY

since 1999

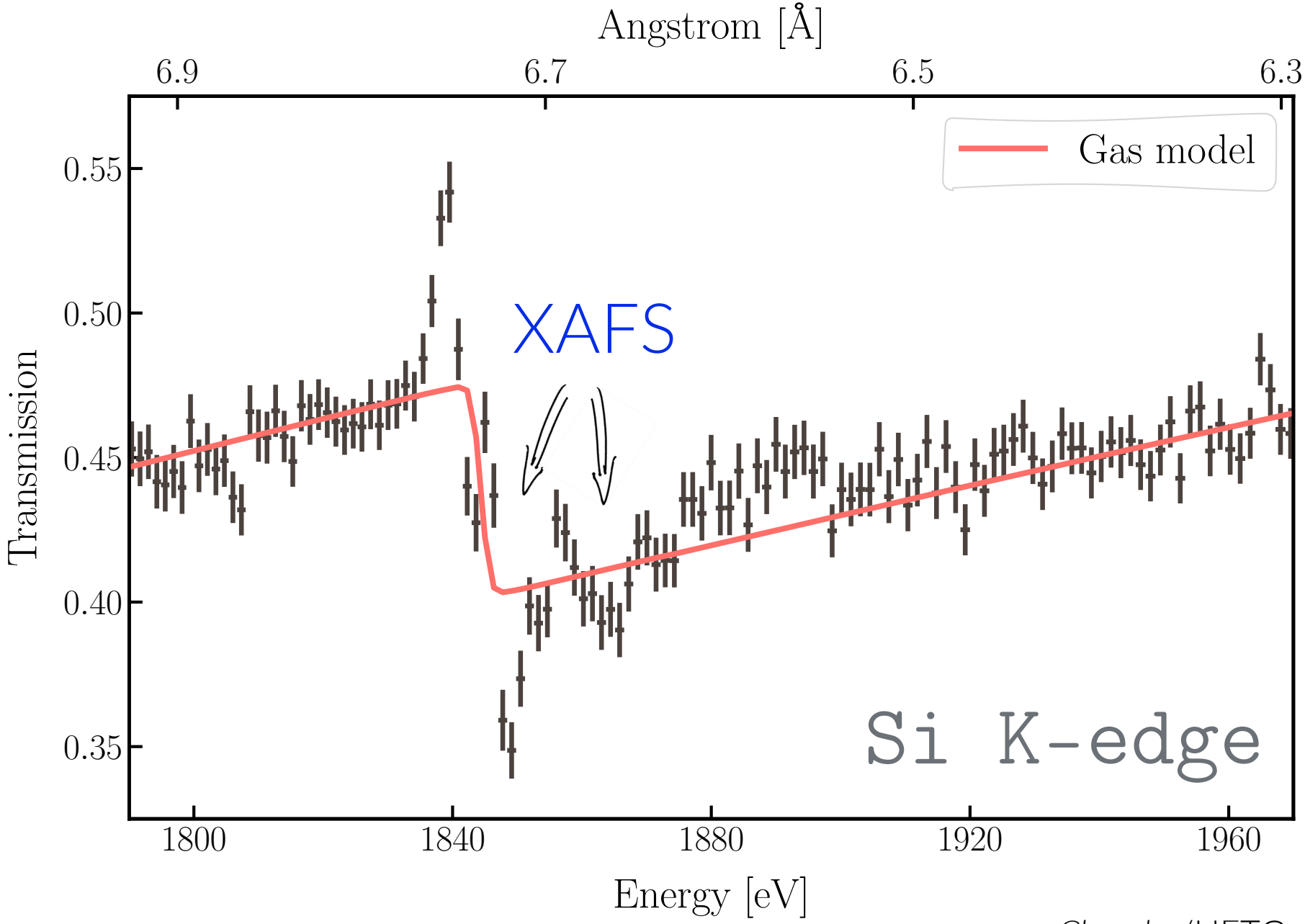




low-mass
X-ray binaries

interstellar
medium

Chandra
XMM-Newton



Chandra/HETG data for GX 3+1

LABORATORY CAMPAING

12 Mg magnesium

13 Al aluminium

14 Si silicon

16 S sulfur

Synchrotron Soleil, Paris

Fluorescence Spectroscopy

26 Fe iron

8 O oxygen

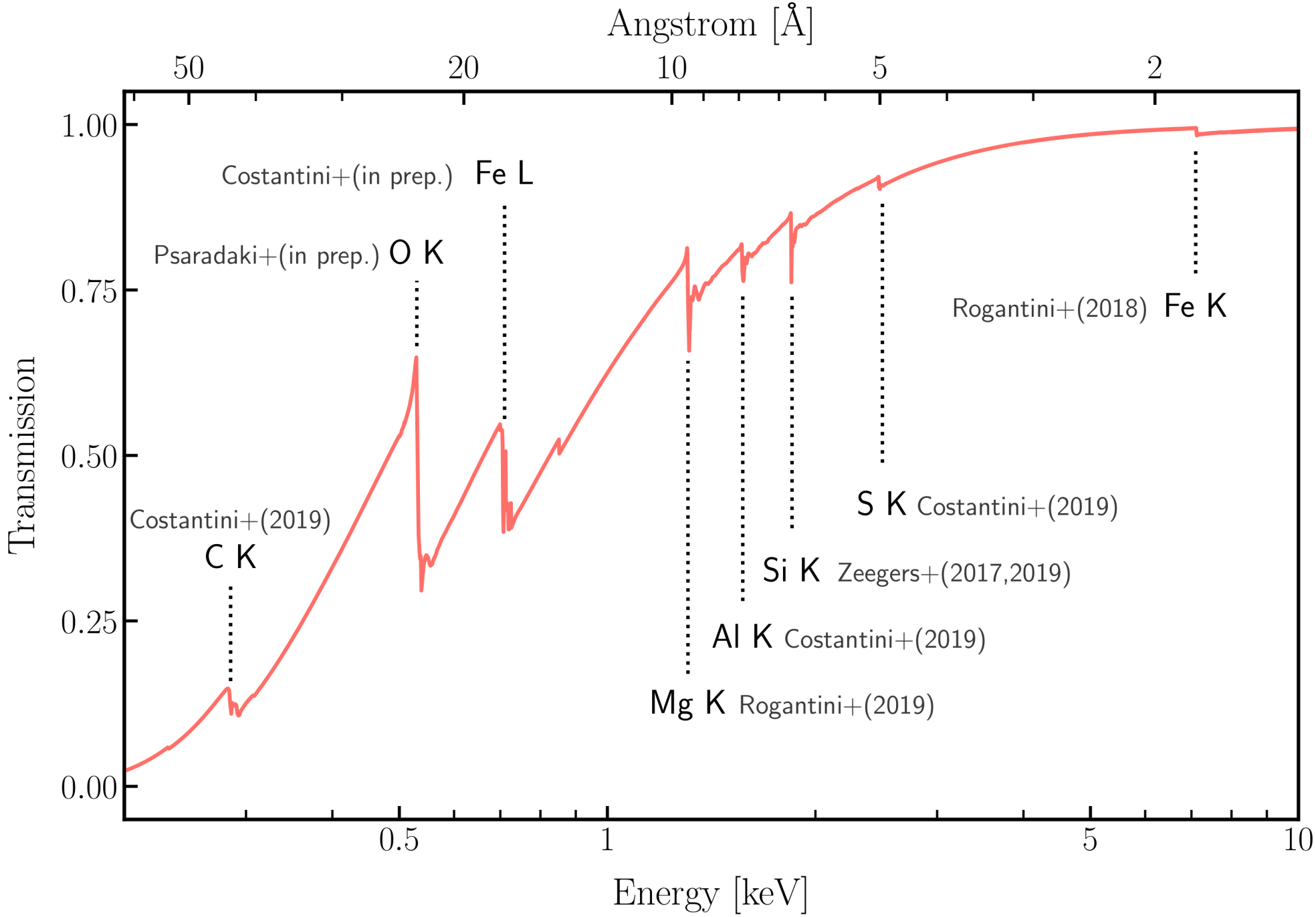
European Synchrotron Radiation Facility, Grenoble

Transmission Spectroscopy

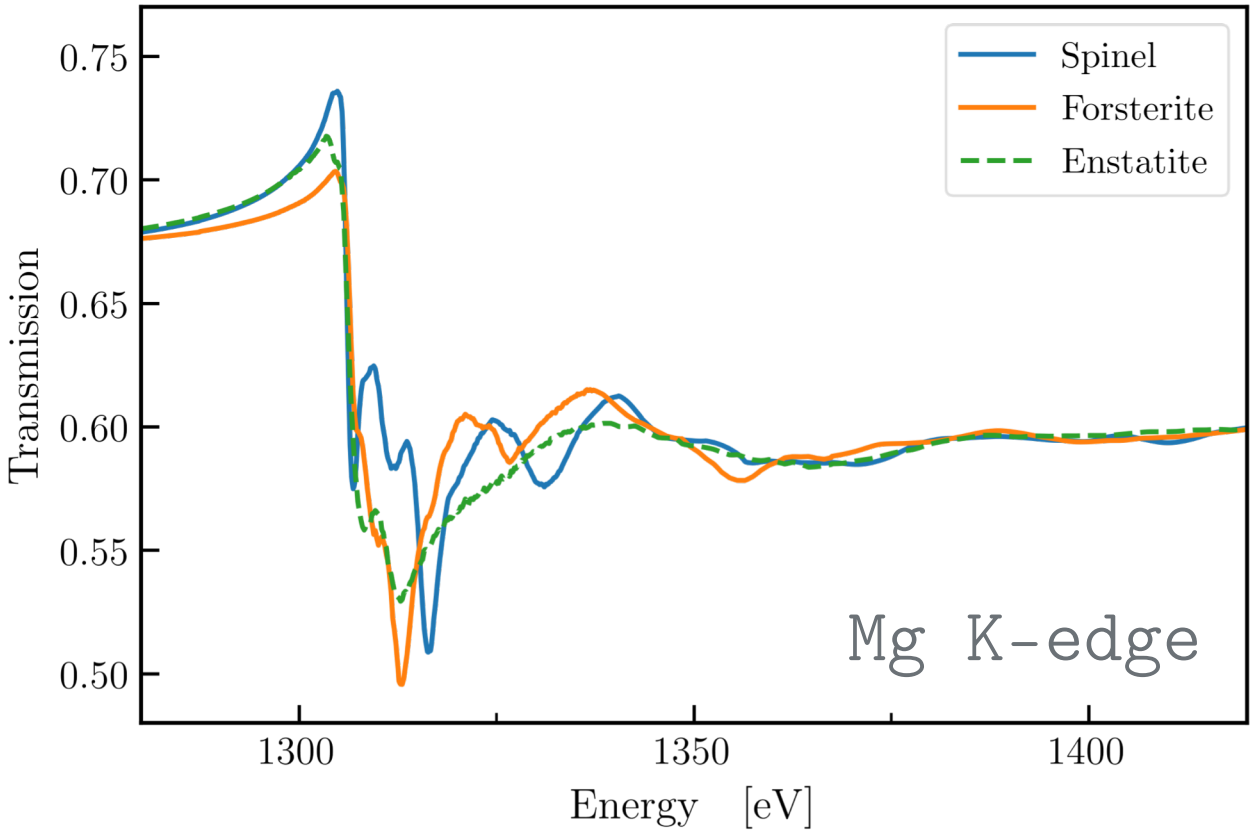
26 Fe iron

Electron Microscope Division, Universidad de Cádiz

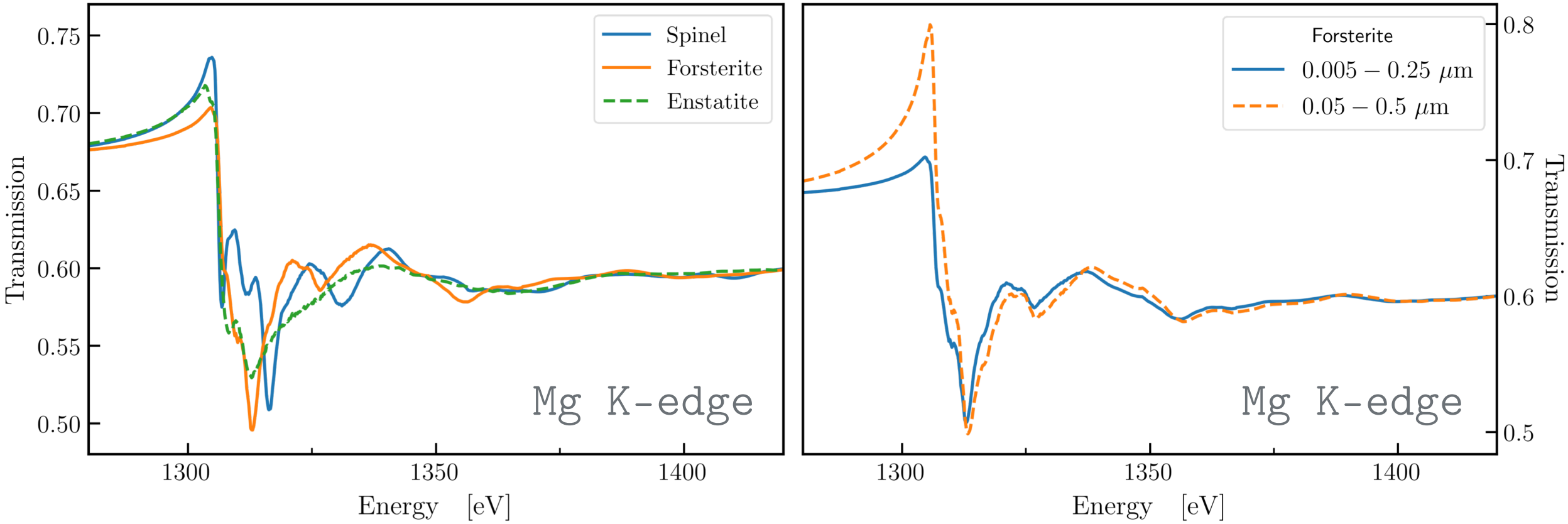
Electron Energy Loss Spectroscopy


Angstrom [Å]
50
20
10
5
2
1.00
0.75
0.50
0.25
0.00
Transmission
Costantini+(in prep.) Fe L
Psaradaki+(in prep.) O K
Costantini+(2019)
C K
Rogantini+(2018) Fe K
S K Costantini+(2019)
Si K Zeegers+(2017,2019)
Al K Costantini+(2019)
Mg K Rogantini+(2019)
0.5
1
5
10
Energy [keV]

MODELS


Spinel
Forsterite
Enstatite
Mg K-edge
Transmission
0.75
0.70
0.65
0.60
0.55
0.50
1300
1350
1400
Energy [eV]

MODELS

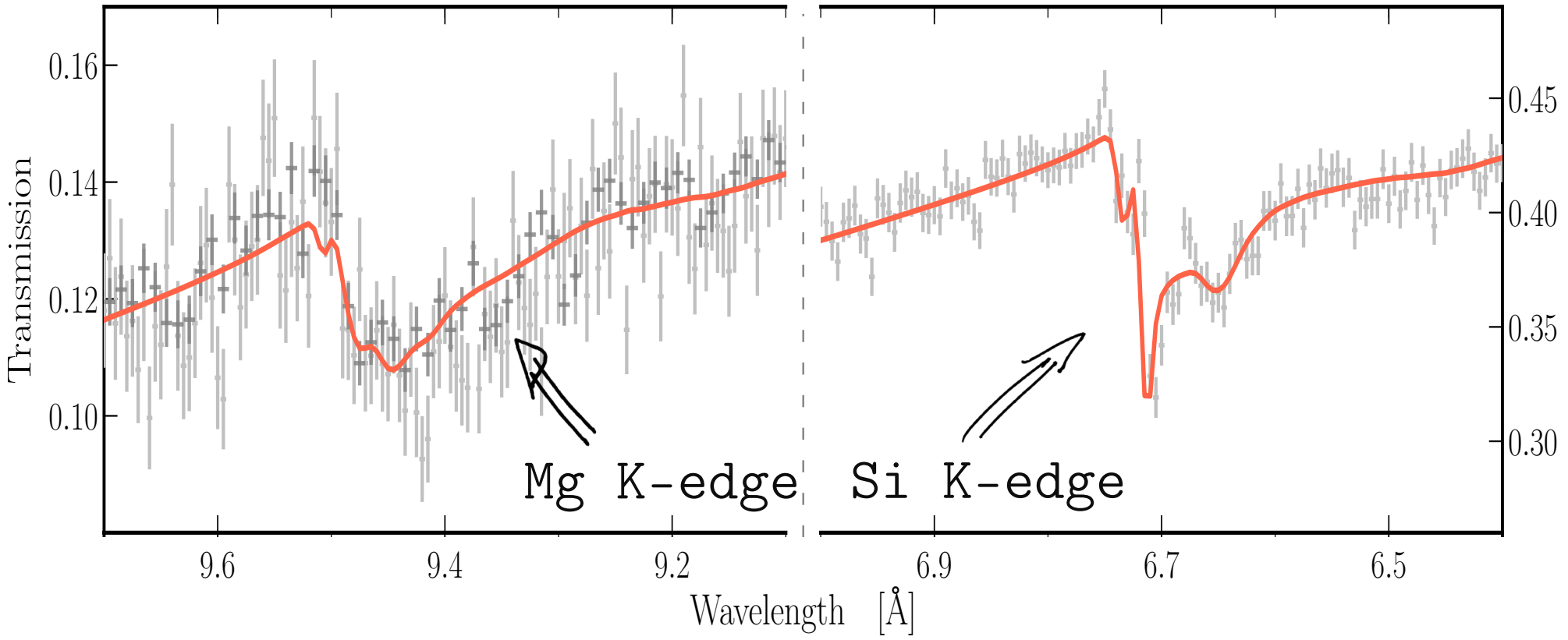


Rogantini et al. (2019)

14
Si
silicon

12
Mg
magnesium

GX 3+1



Rogantini et al. 2019

MAPPING THE GALACTIC CENTER

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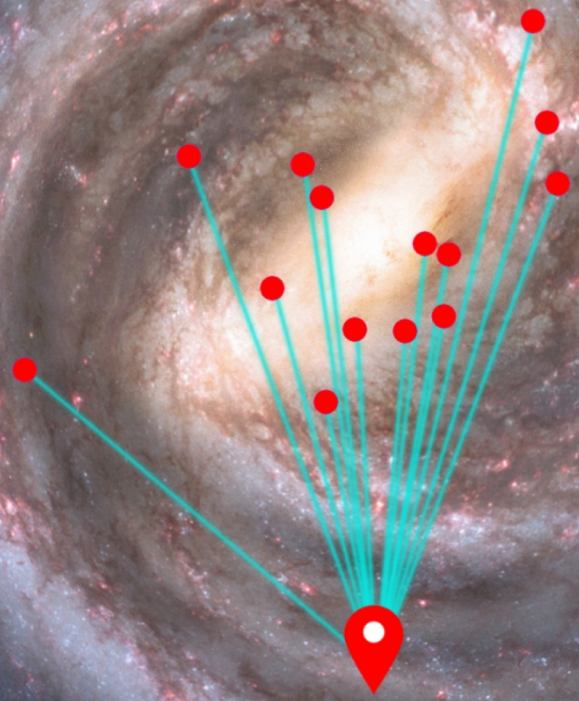
14 X-ray binaries
within 5 kpc from GC

$\langle N_H \rangle \sim 10^{22}$ cm^{-2}
$\langle F_X \rangle \sim 10^{-9}$ erg cm^{-2} s^{-1}



Zeegers et al. (2019)
Rogantini et al, (to be subm.)

RESULTS

Amorphous olivine ($MgFeSiO_4$) represents 60-90% of the dust in dense environments

Rogantini et al. (2019)
Zeegers et al. (2019)

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Amorphous olivine ($MgFeSiO_4$) represents 60-90% of the dust in dense environments

3-15% of crystalline dust versus 2% observed in infrared

Rogantini et al. (2019)
Zeegers et al. (2019)

RESULTS

Amorphous olivine ($MgFeSiO_4$) represents 60-90% of the dust in dense environments

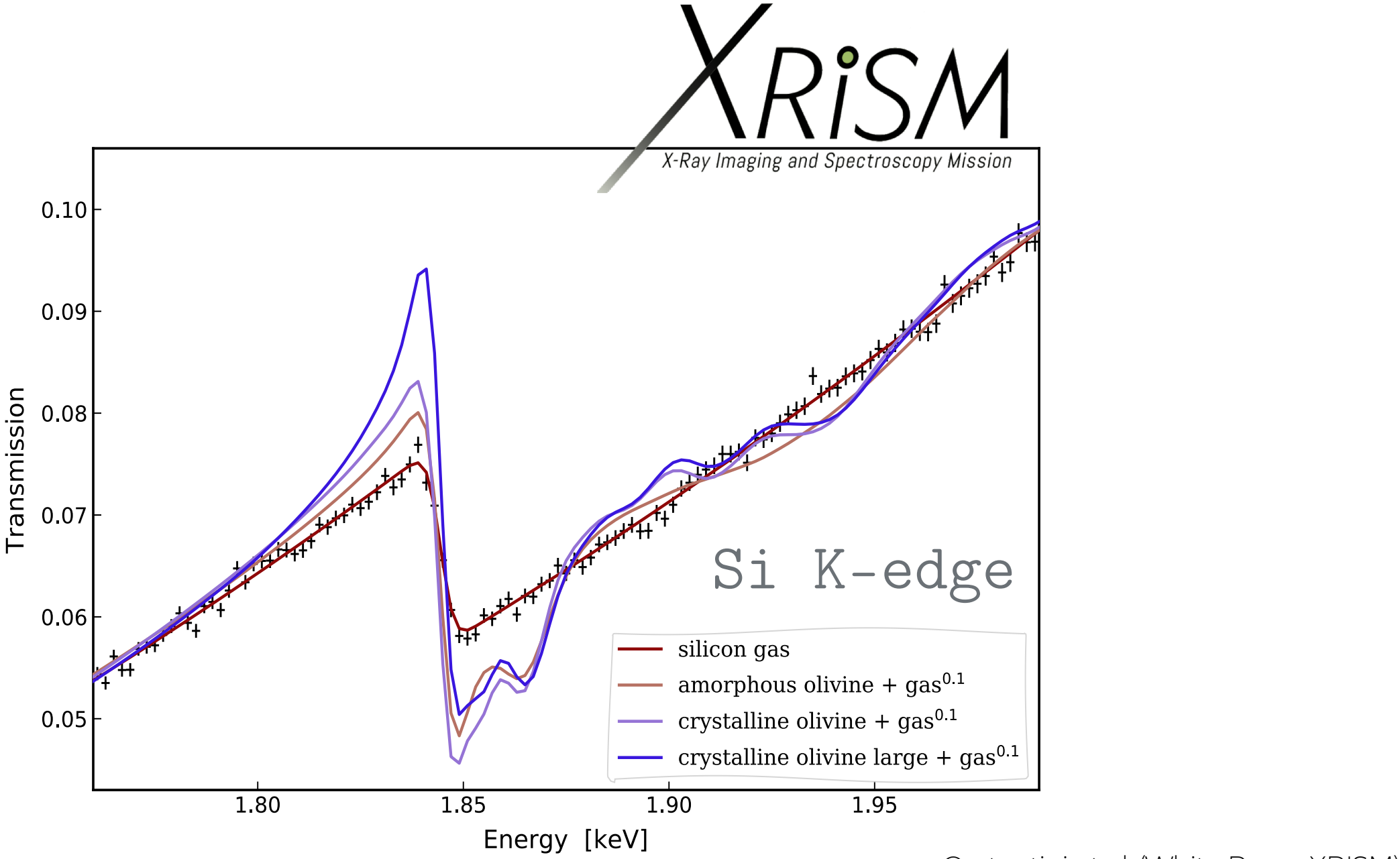
3-15% of crystalline dust versus 2% observed in infrared

Solar abundances of silicon and magnesium

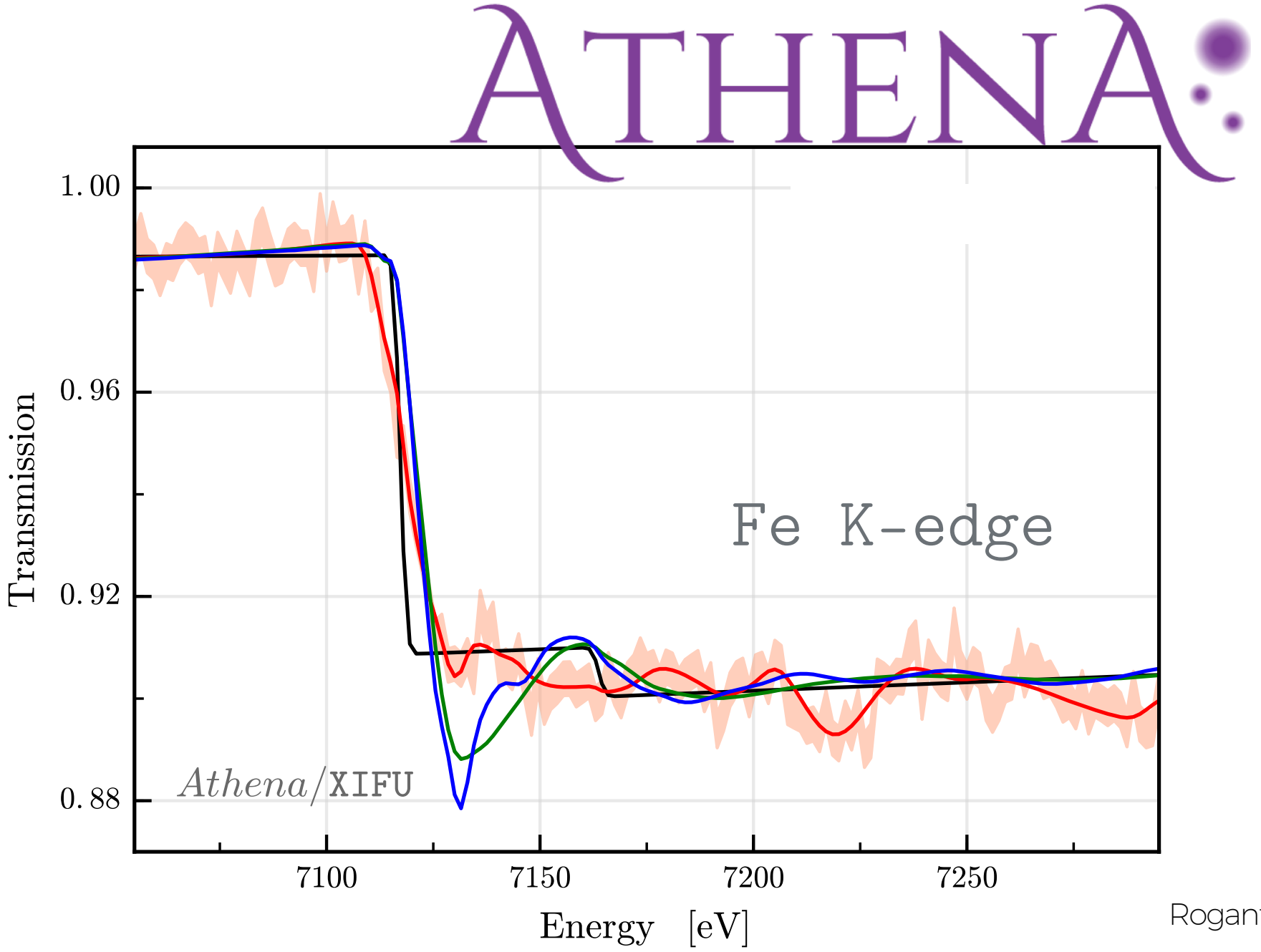
>90% of silicon and magnesium is locked into dust

Rogantini et al. (2019)
Zeegers et al. (2019)

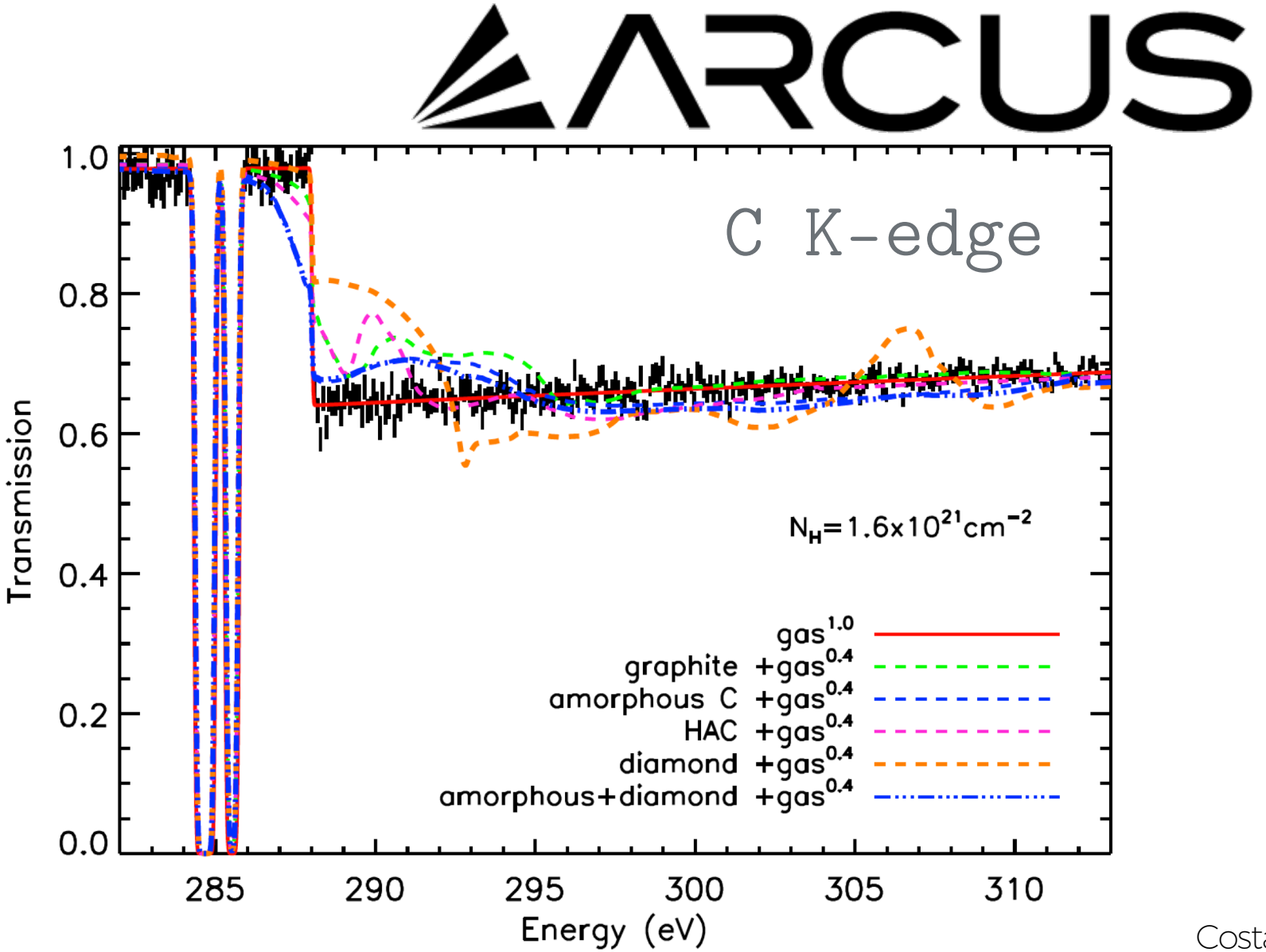

X-RAYS
TO THE FUTURE



Costantini et al. (White Paper XRISM)

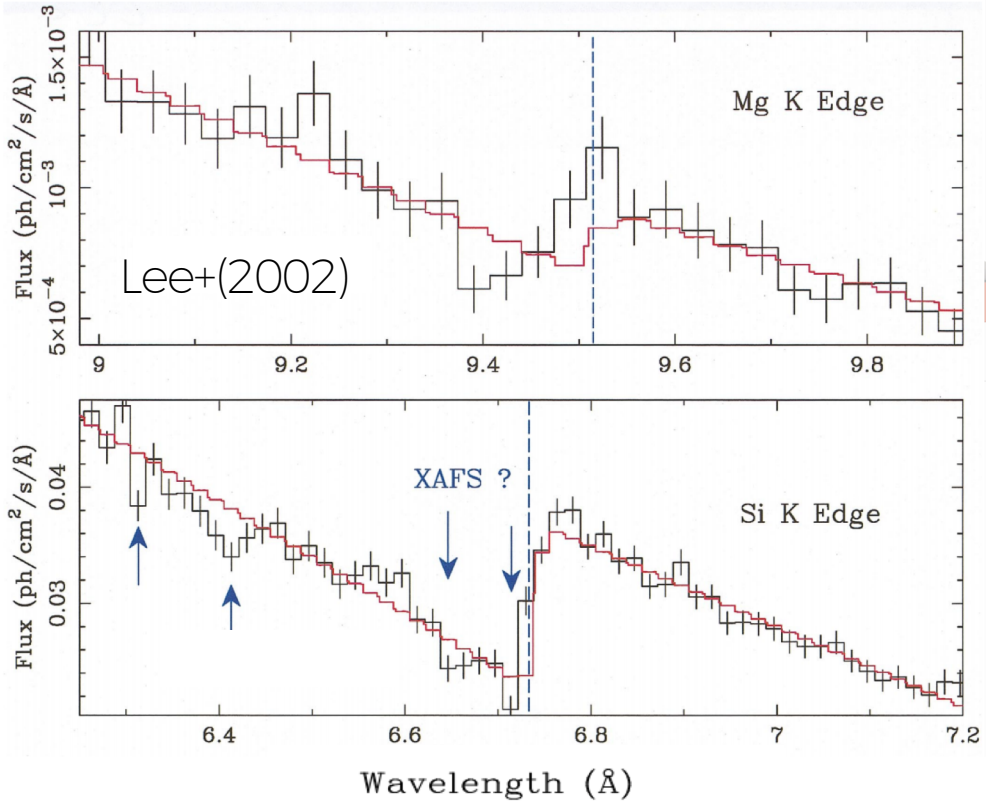


Rogantini et al. (2018)

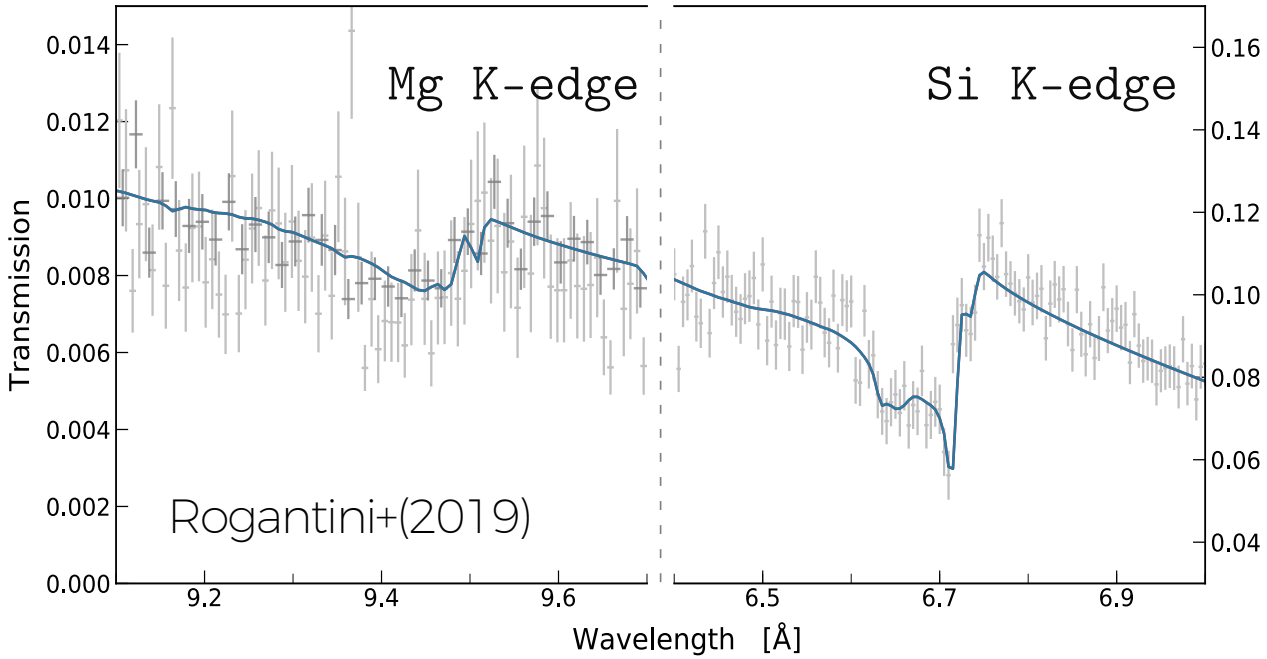


Costantini et al. (2019)

BEFORE



AFTER



TAKE HOME MESSAGE

The synergy between high-resolution X-ray spectra of bright binaries and our new extinction model allows us to study the chemical and physical properties of the cosmic dust