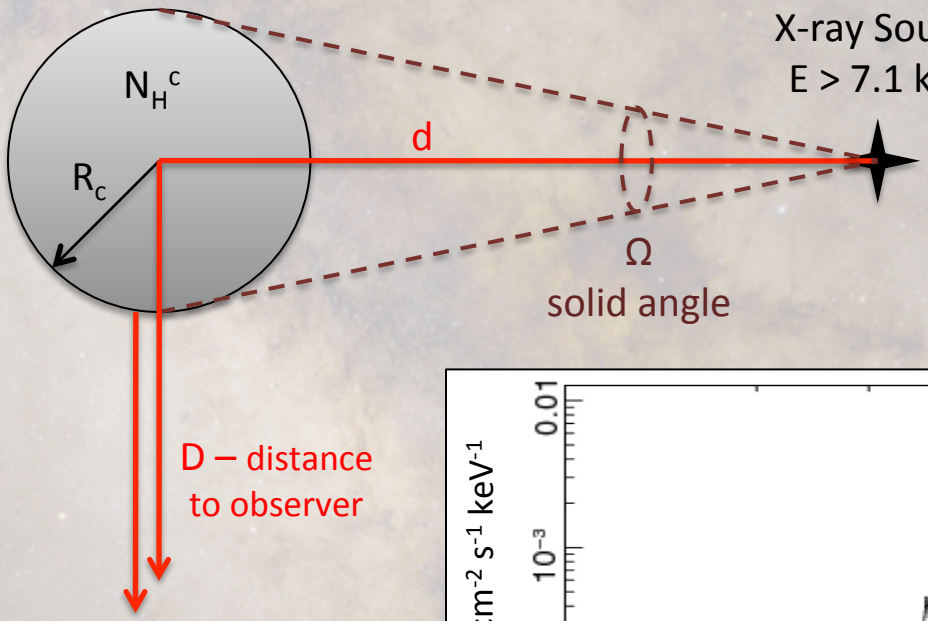
THE REFLECTION OF TWO PAST OUTBURSTS OF SAGITTARIUS A* OBSERVED BY CHANDRA DURING THE LAST DECADE

Maïca Clavel, R. Terrier, A. Goldwurm, M. Morris, G. Ponti, S. Soldi and G. Trap

Clavel et al. 2013, A&A, 558, A32

Sgr A* past activity – Reflection process

Molecular cloud



Fluorescence

&

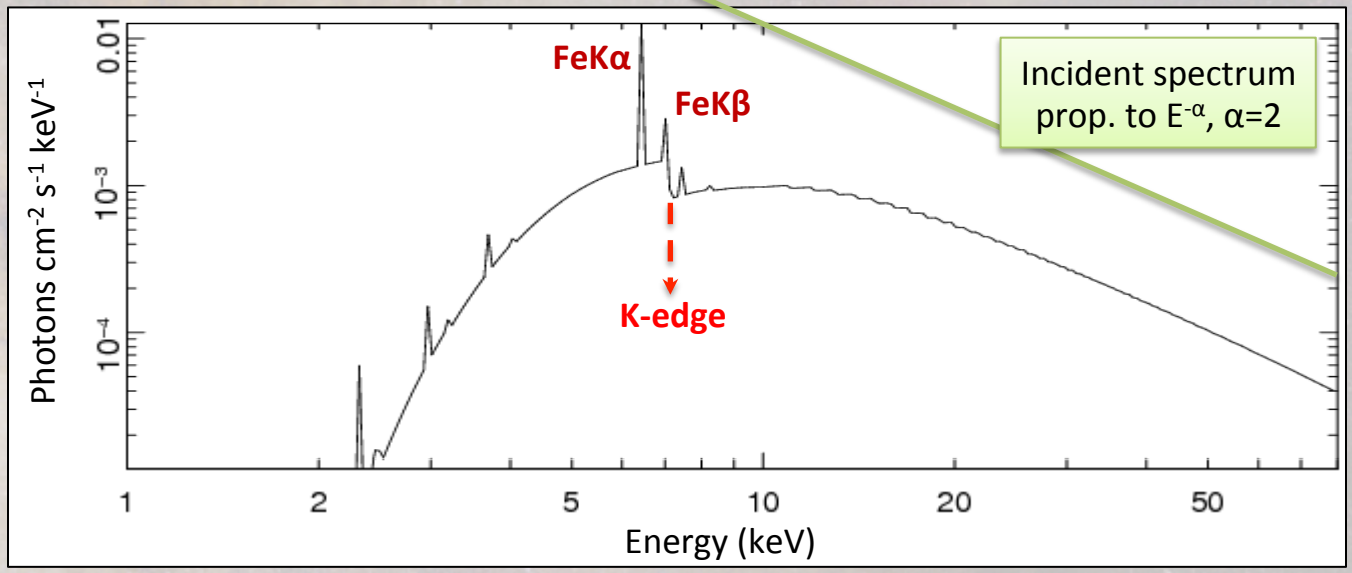
Scattered X-rays

Reflected signal

Time delay due to longer path

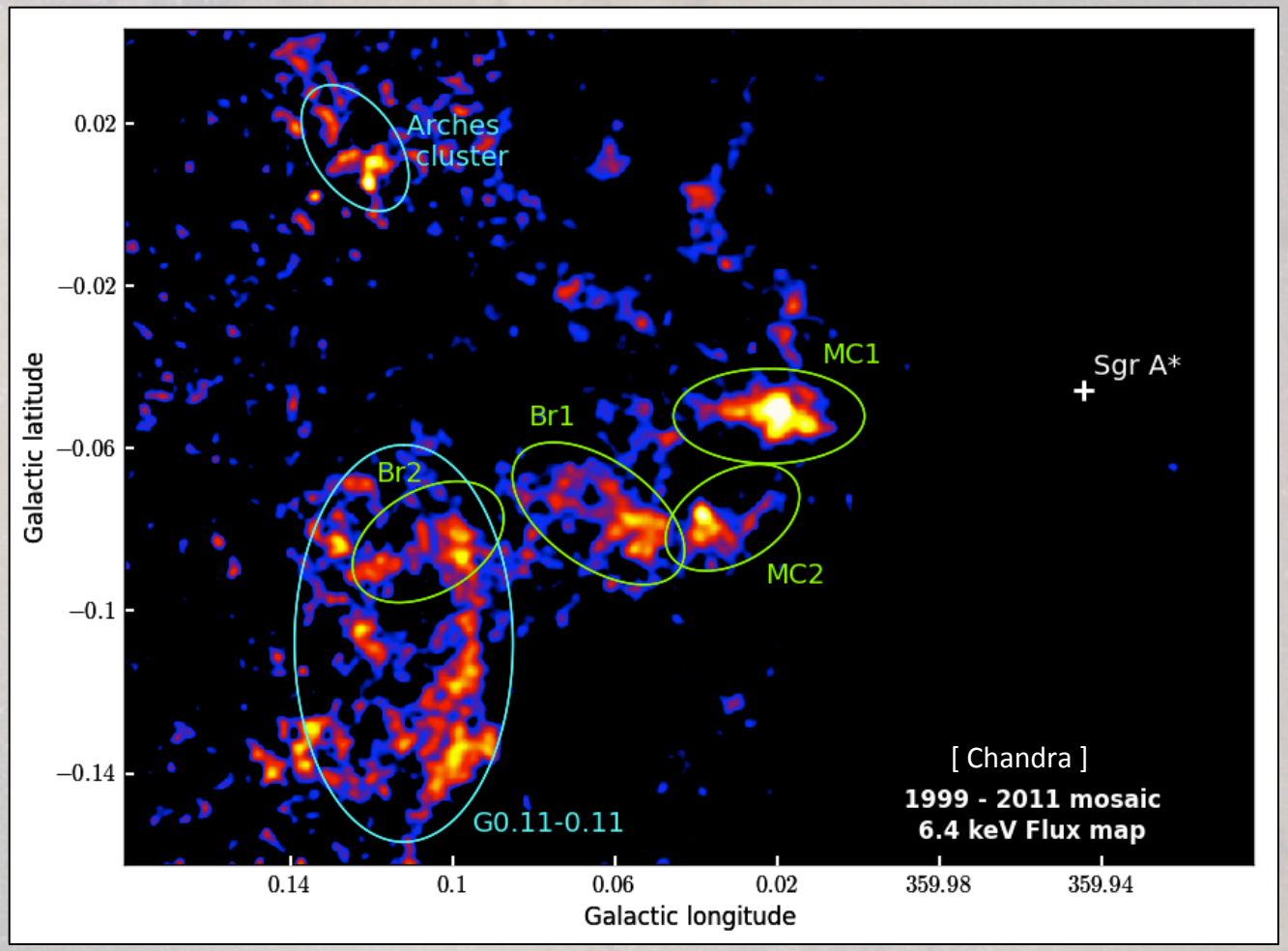
Direct link to Sgr A* past luminosity

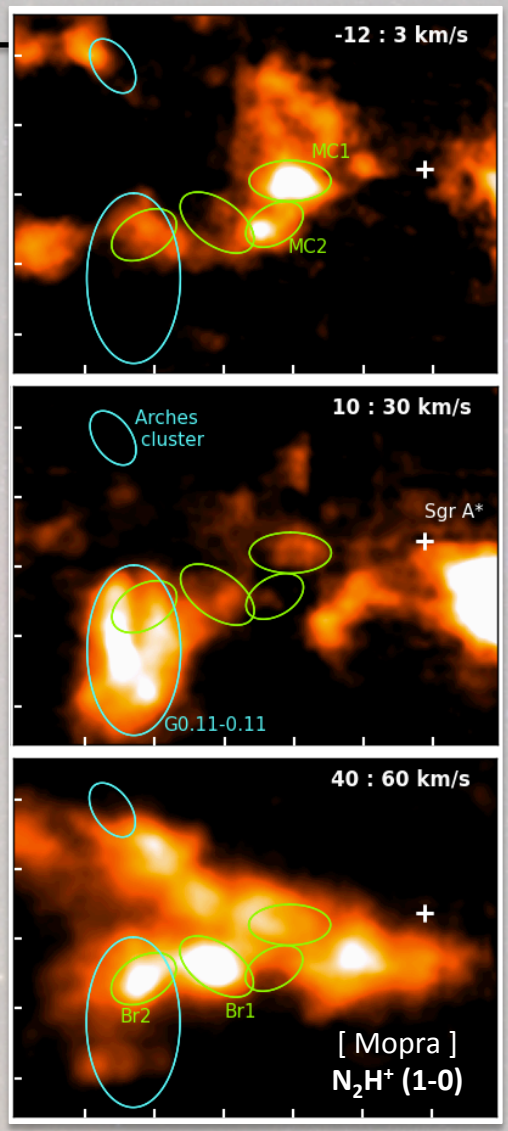
$$F_{6.4keV} \propto L_X \times \frac{R_c^2}{d^2} \times \frac{N_H^c}{D^2}$$



6.4 keV Diffuse Emission in molecular clouds

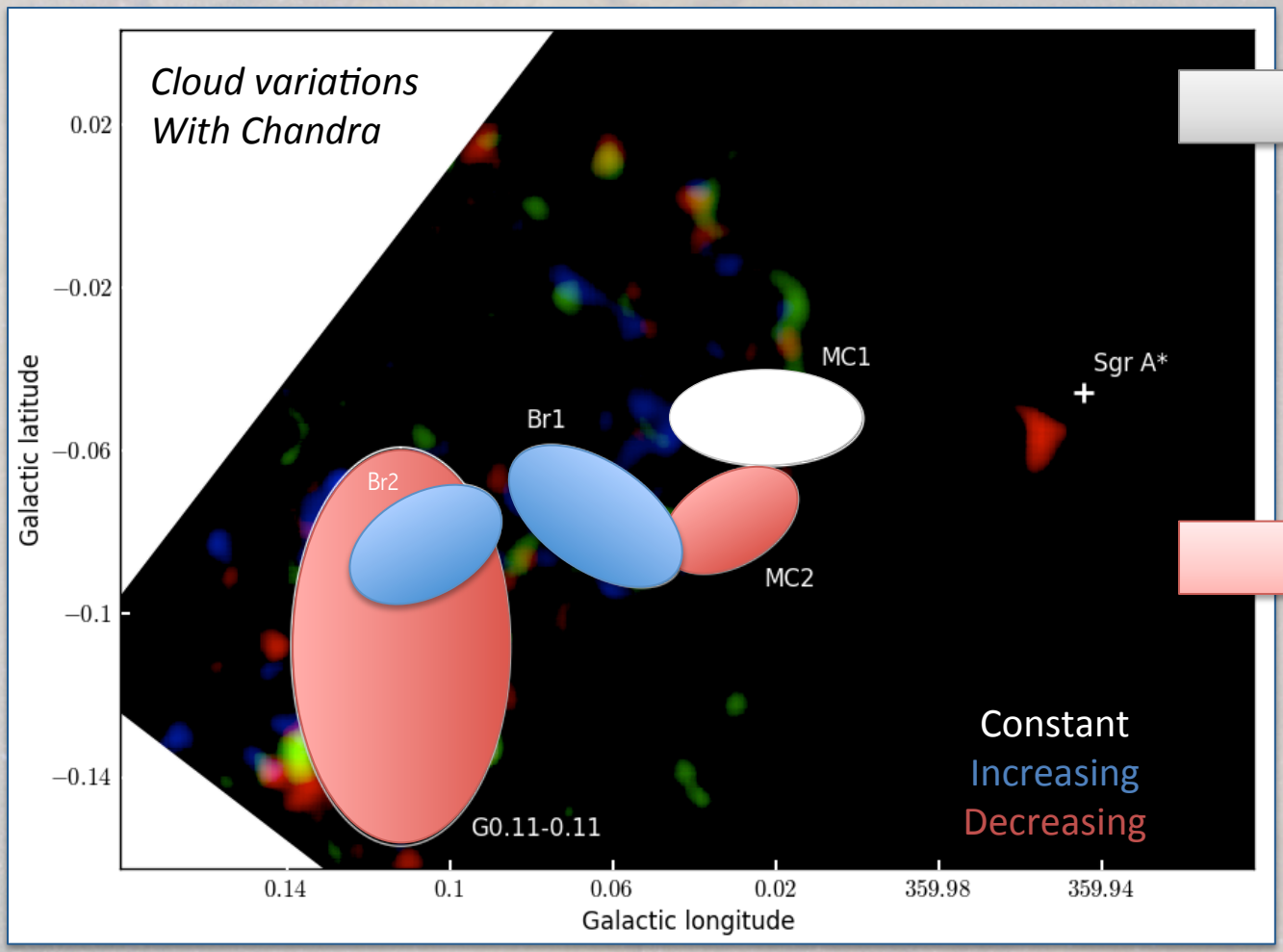
Strong diffuse emission correlated with molecular structures





6.4 keV Diffuse Emission – Large scale variations

Strong variations in a ten-year time scale



Previous works

Large region trends:

Ponti et al. 2010
Capelli et al. 2012

→ Spectral analysis

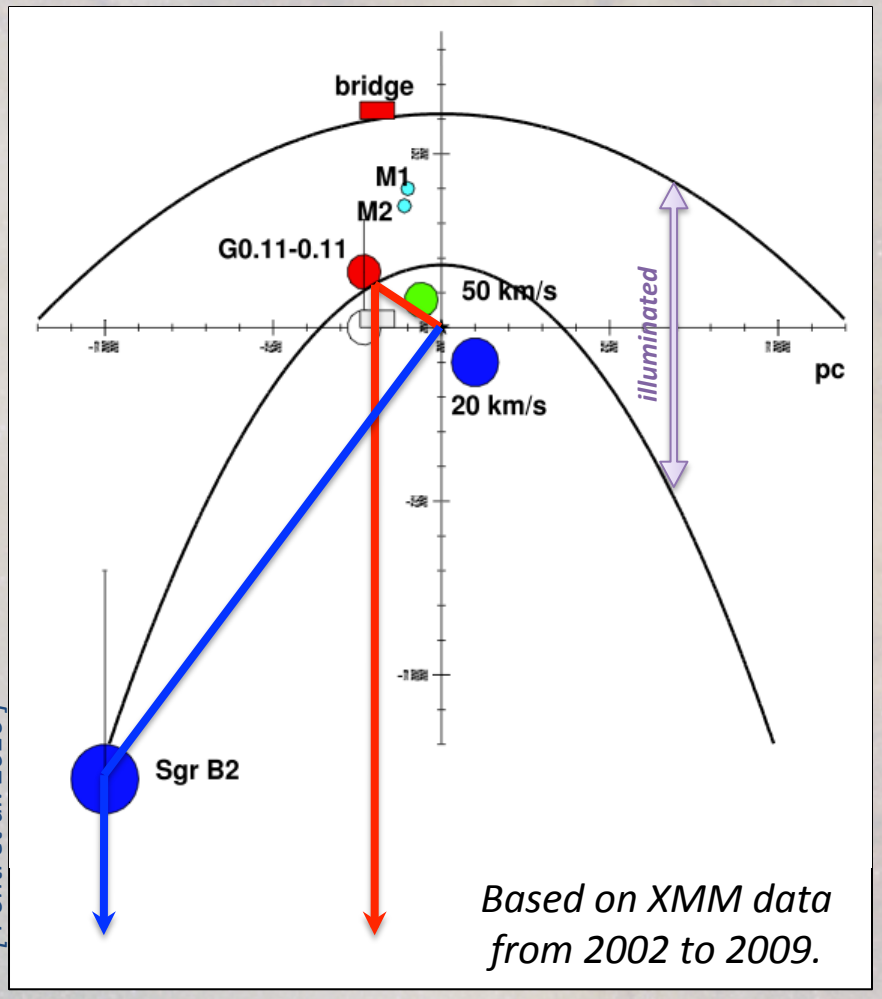
Limitation

→ Different clouds along the line of sight

→ Sub-regions with different variation pattern

Diffuse Emission - Current issues

Previous illumination model



[Ponti et al. 2010]

Known

Part of the emission is due to **Reflection**

The emission is **Varying** / **Propagating**

Unclear

Molecular cloud parameters

Characteristics of the **Flare(s)**

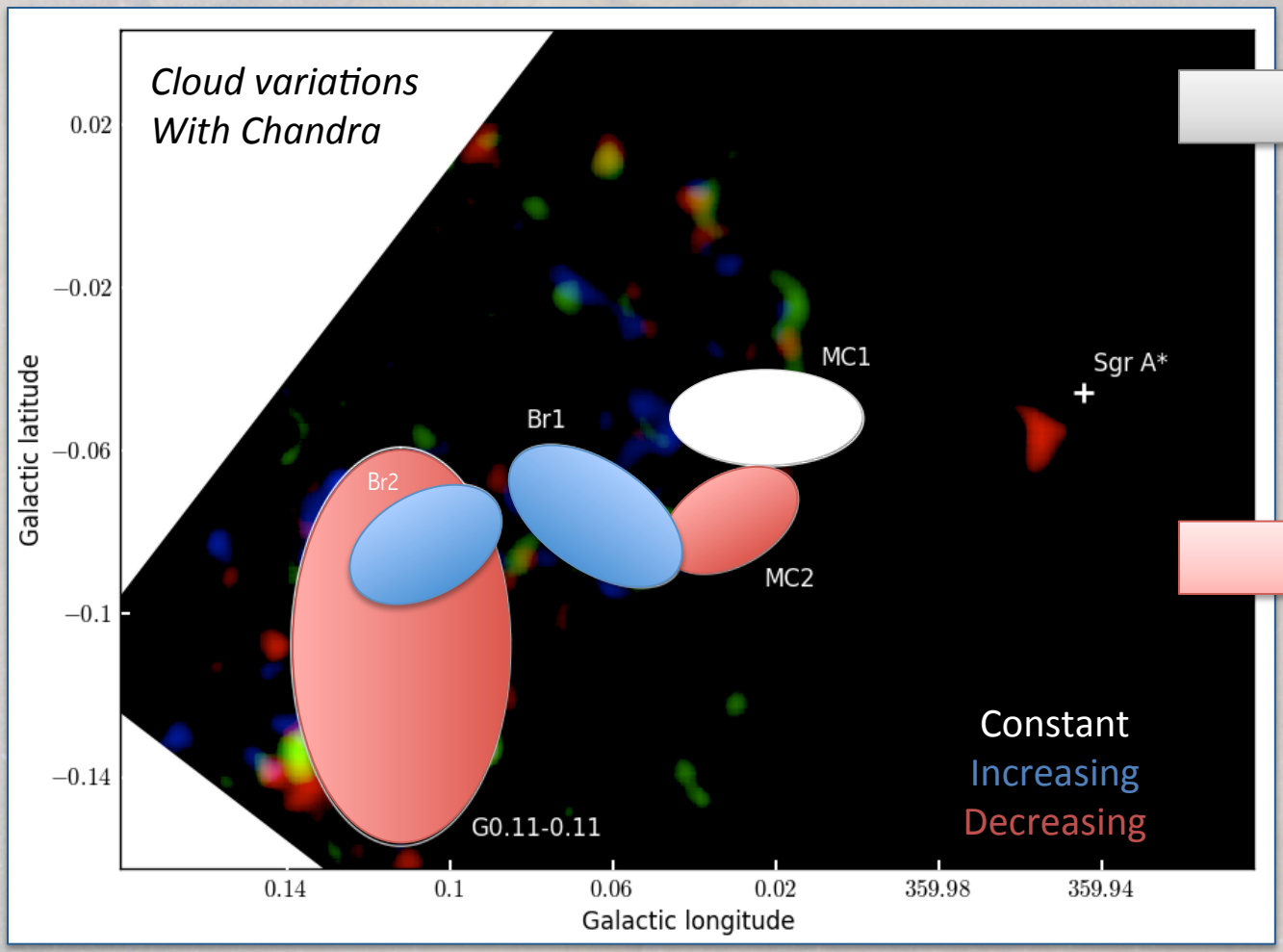
Aim of my work

To use **Chandra** high resolution capability to highlight the **illumination fine structure**

To obtain a **more accurate profile of Sgr A* past activity**

6.4 keV Diffuse Emission – Large scale variations

Strong variations in a ten-year time scale



Previous works

Large region trends:

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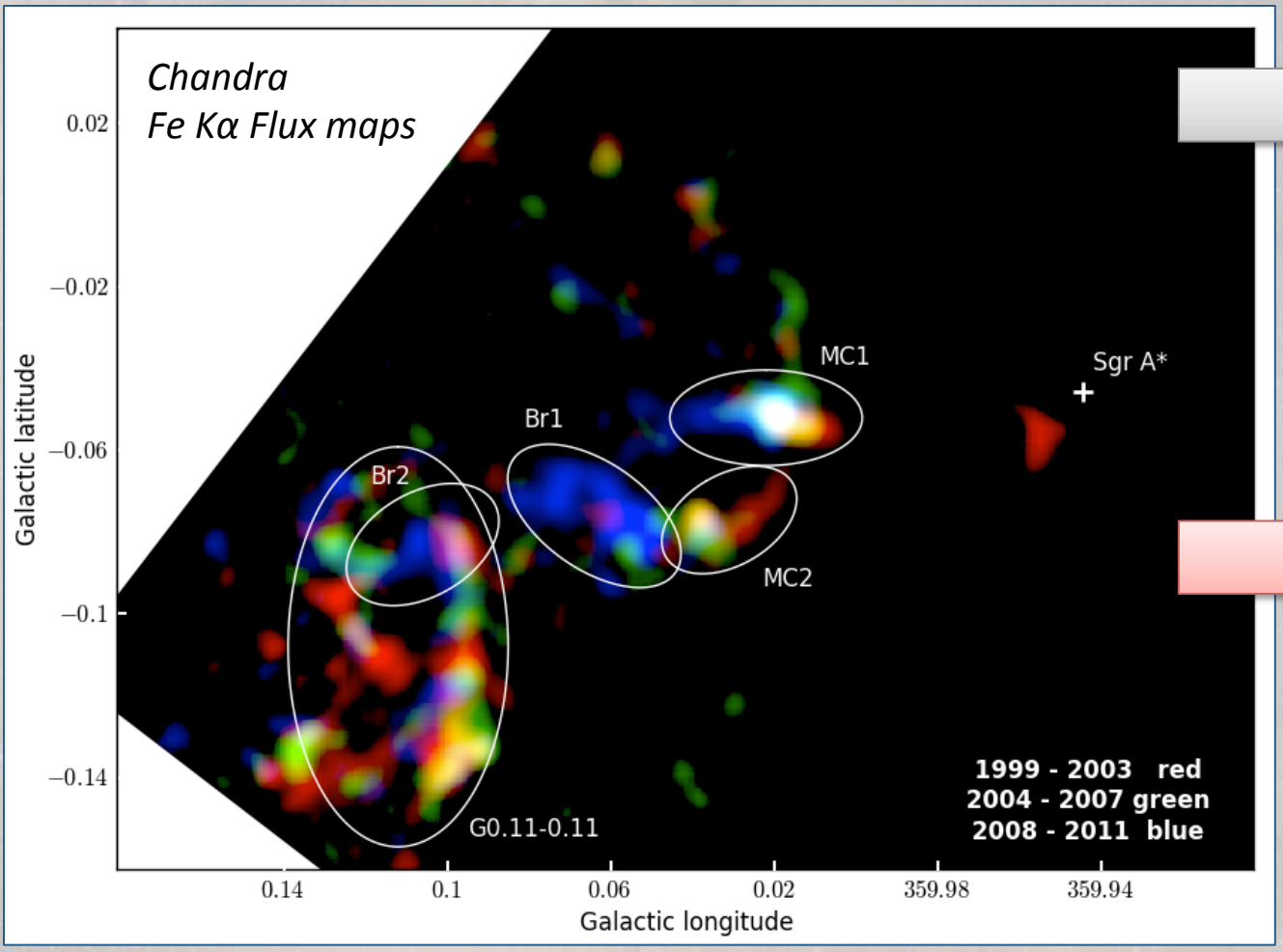
6.4 keV Diffuse Emission – Small scale variations

Strong variations in a few year time scale



Previous works

Large region trends:

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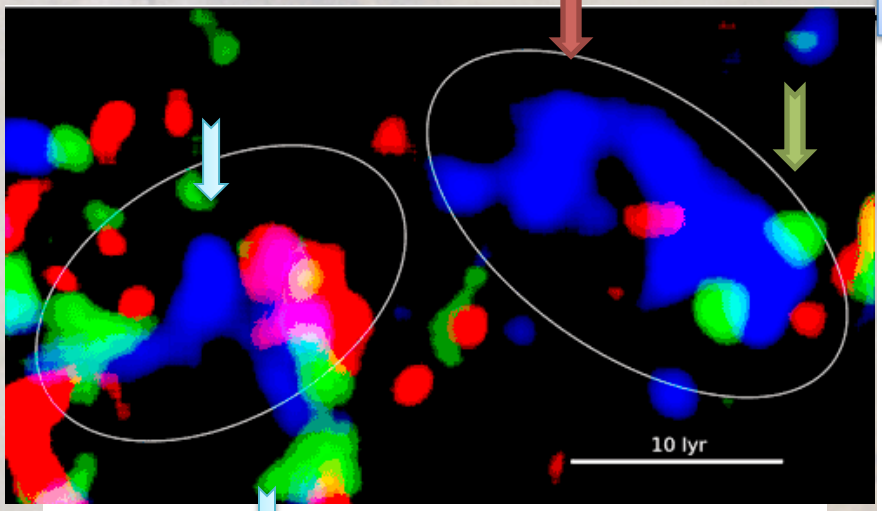
→ Spectral analysis

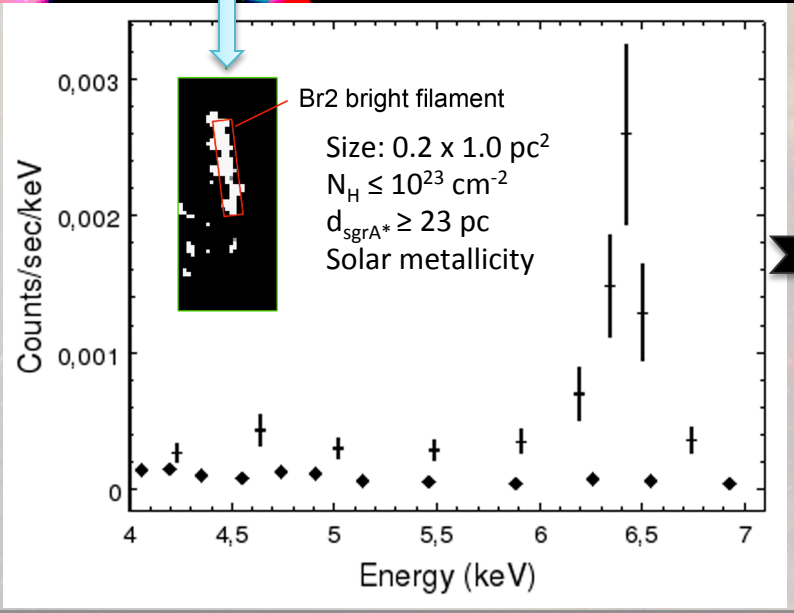
New Results

→ Apparent signal propagation in all clouds

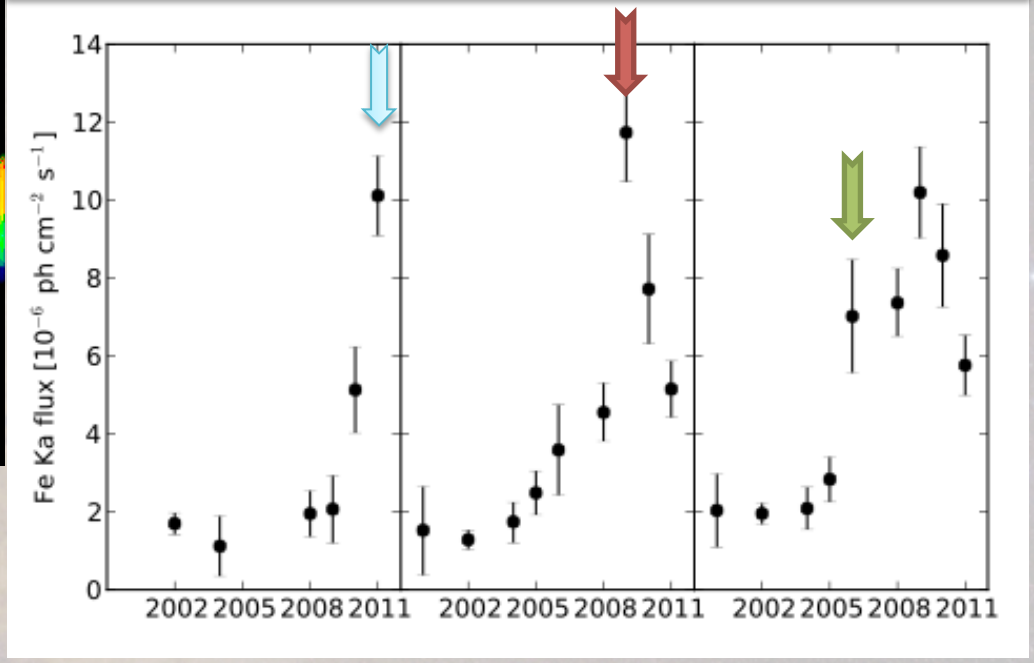
→ Variations more complex than anticipated

Bridge: Two-year peaked variation





Propagation along Bridge confirmed



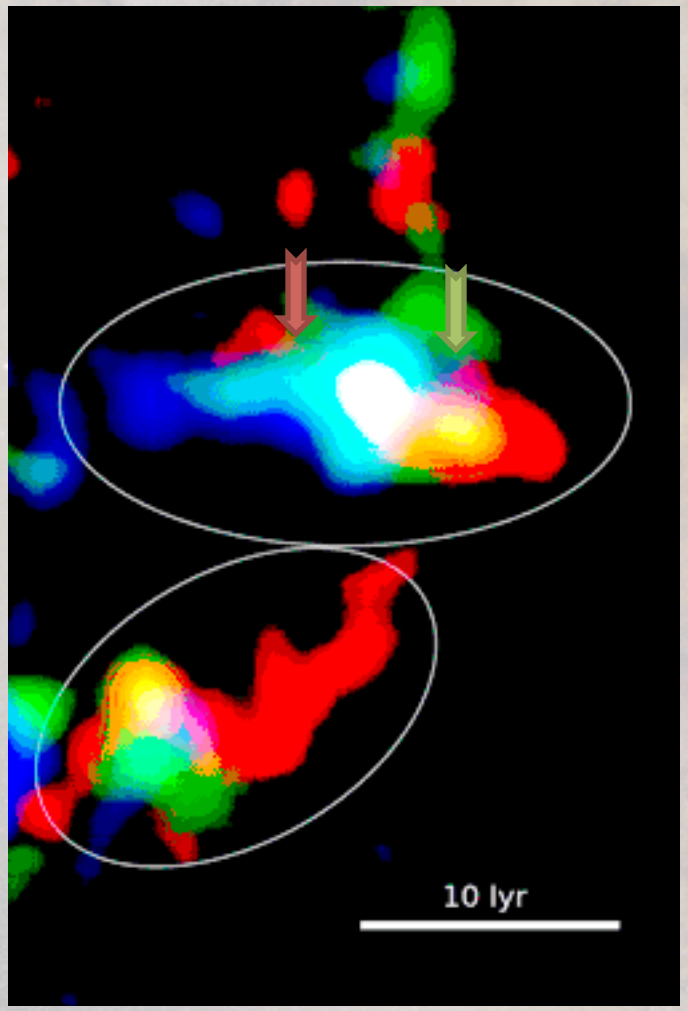
Flux increases by **a factor greater than 10**

Reflected FeKα flux (3.2 ± 0.6) x 10⁻⁶ ph cm⁻² s⁻¹

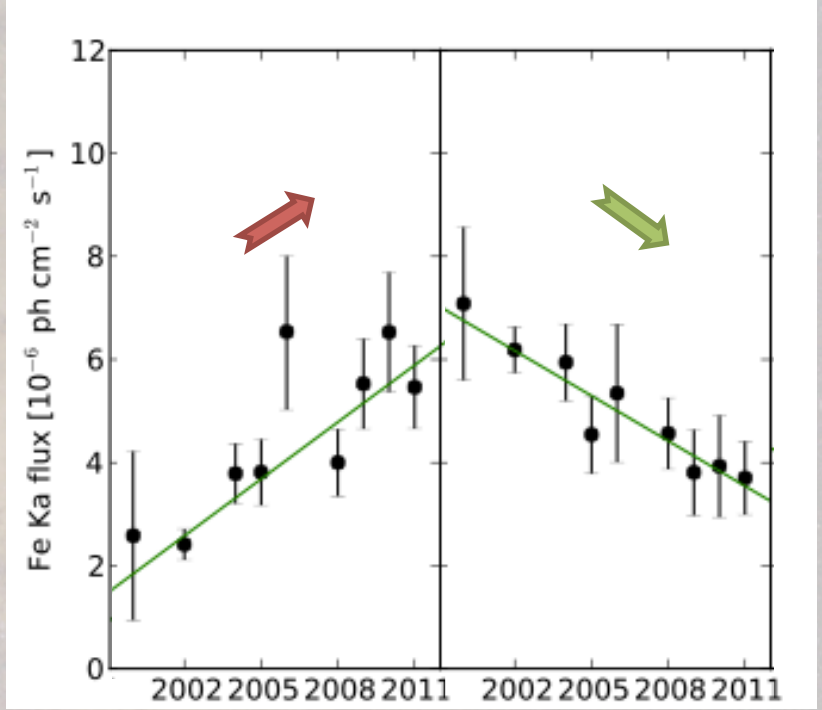
Sgr A* past luminosity: $L_x > 10^{39}$ erg s^{-1}

Variations faster than predicted: **Short Flare**

MC1: Different time behavior



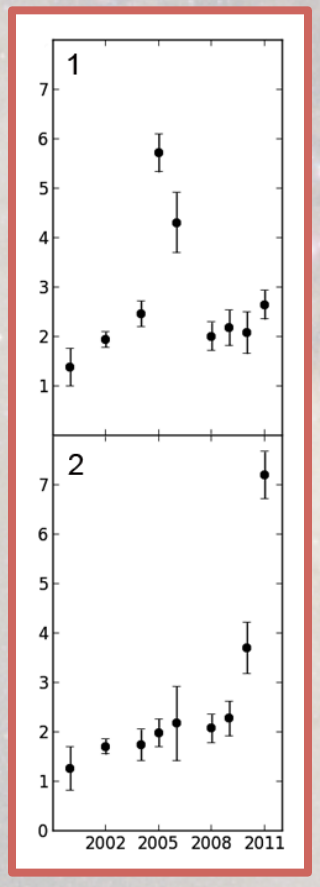
First detection of a signal propagation inside MC1



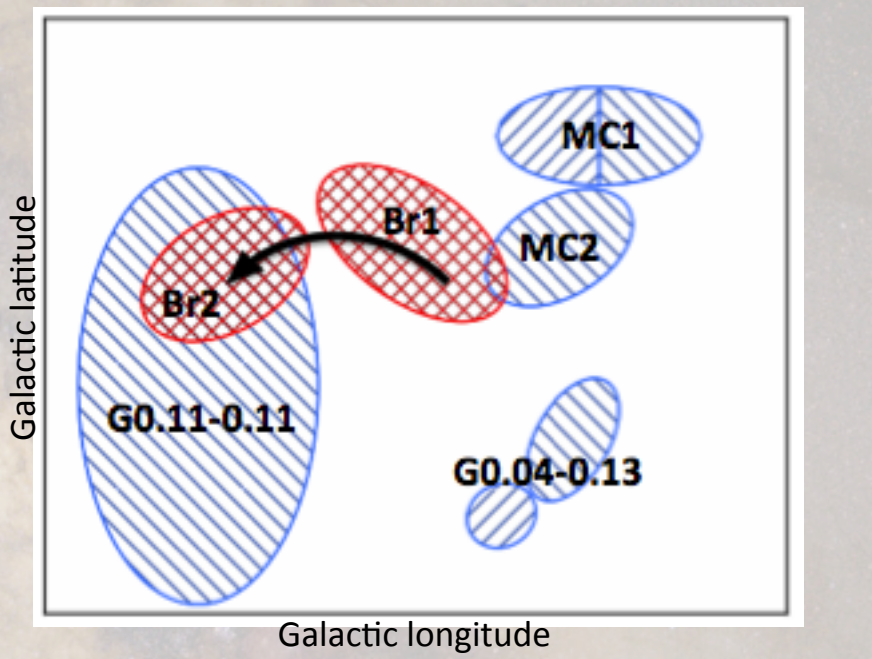
10-year linear variations

Contrast with the 2-year peaked variations in the Bridge

Systematic 4-8 keV analysis of the variations



Bridge

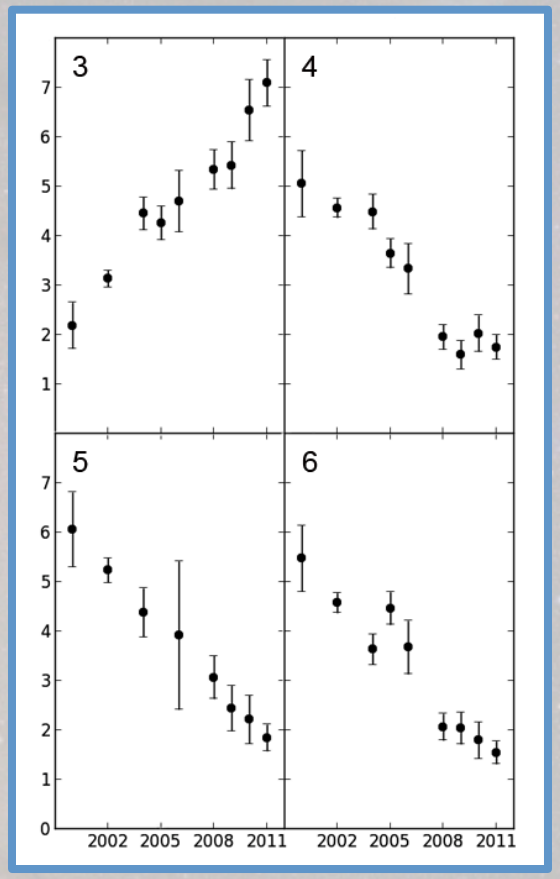


2-year
Peaked variation

Signal Propagation

10-year
Linear increase

10-year
Linear decrease

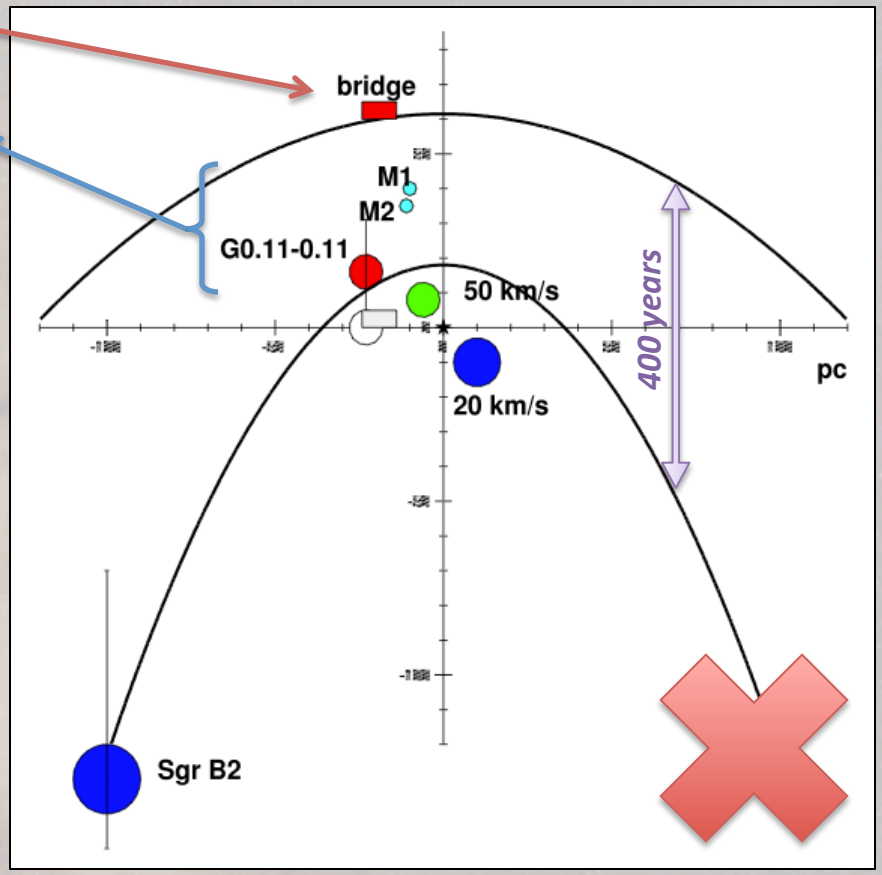


MC1, MC2 and G0.11-0.11

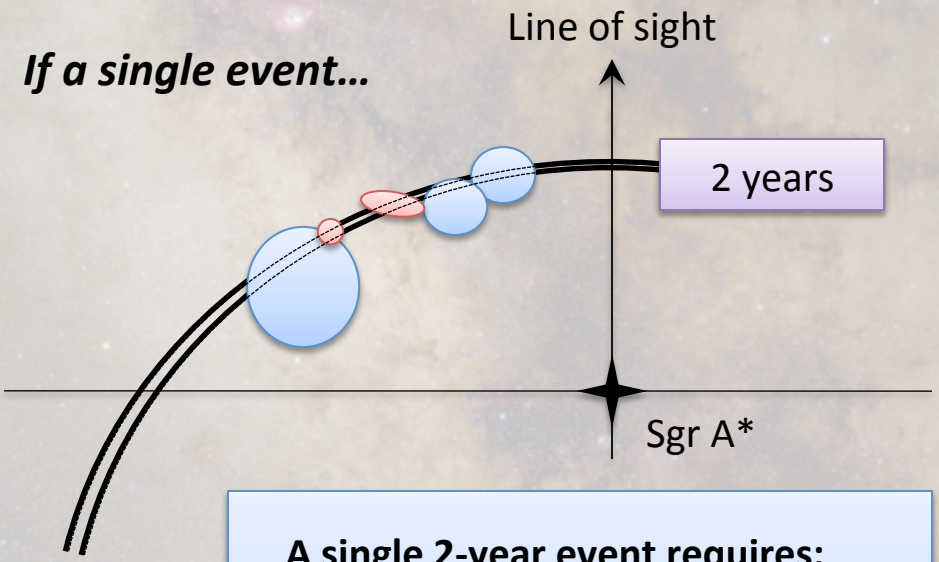
Constraints on the single event scenario

2-year peaked variation

10-year linear variation



If a single event…

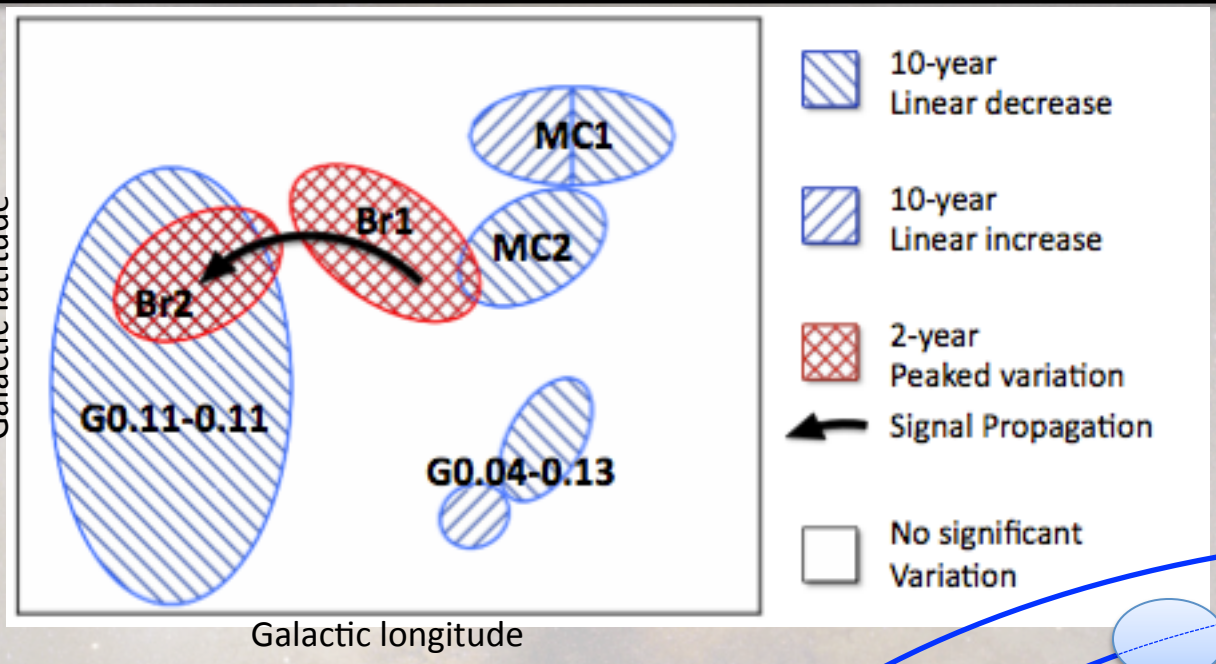


A single 2-year event requires:

Extension along the line of sight
Higher density than the Bridge

In contradiction with observations

Conclusion: Two illuminating events



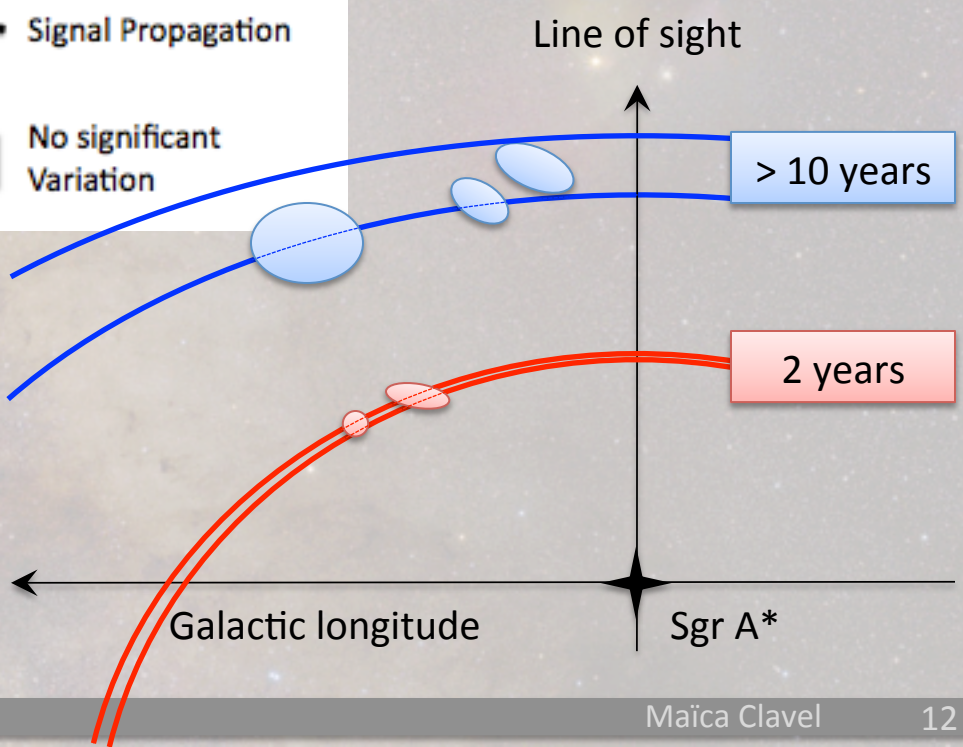
Highlights:

1st systematic analysis
1st upper limit on flare duration

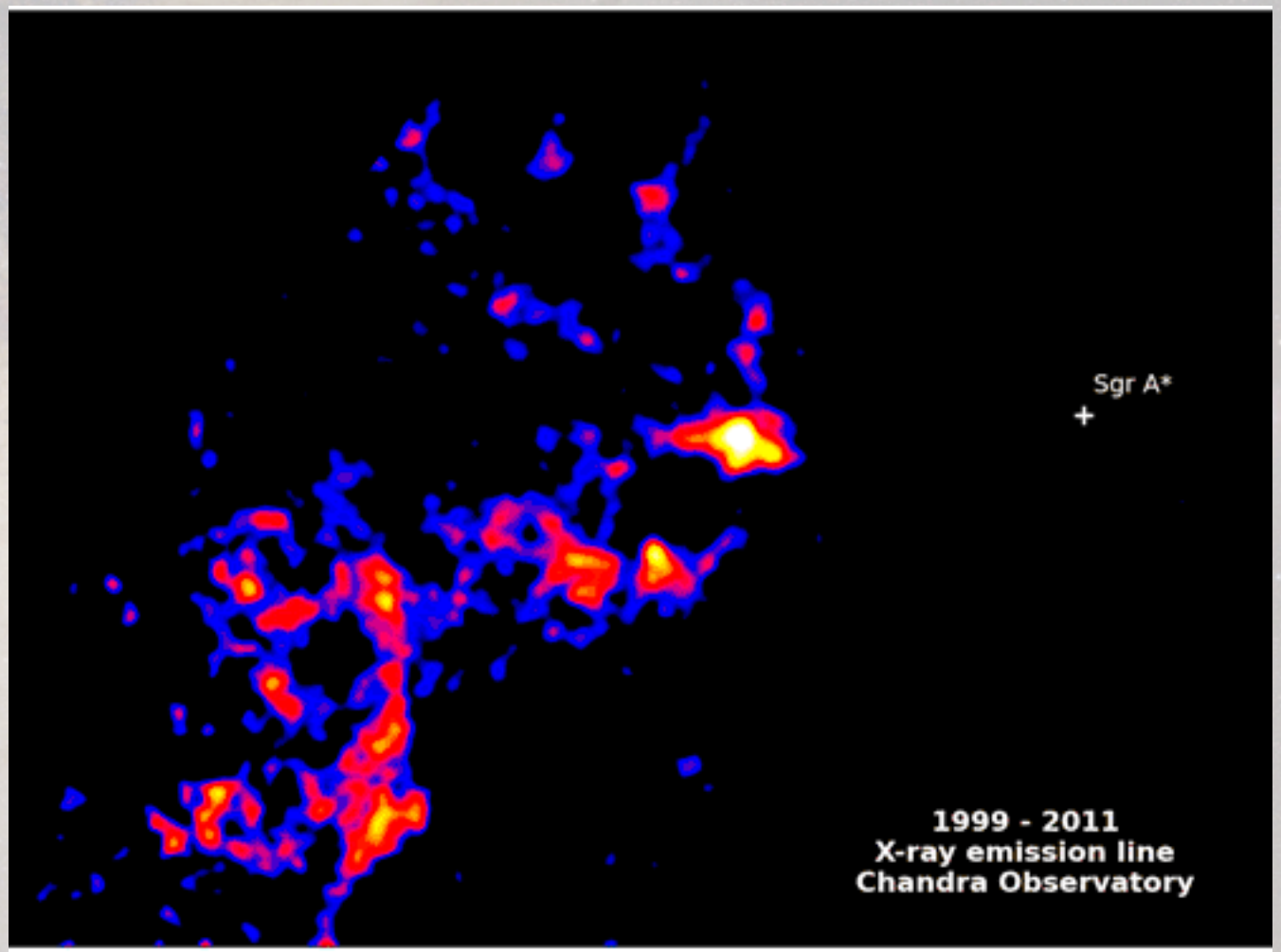
Two-flare scenario:

$L_X > 10^{39}$ erg s^{-1} but **different durations**

Unknown: *Date*, *Order*, *Underlying level*



The reflection of two past outbursts of Sgr A* observed by Chandra during the last decade



Merci !