THE POWERS OF THE GRB 221009A SOFT X-RAY RINGS

ID #273

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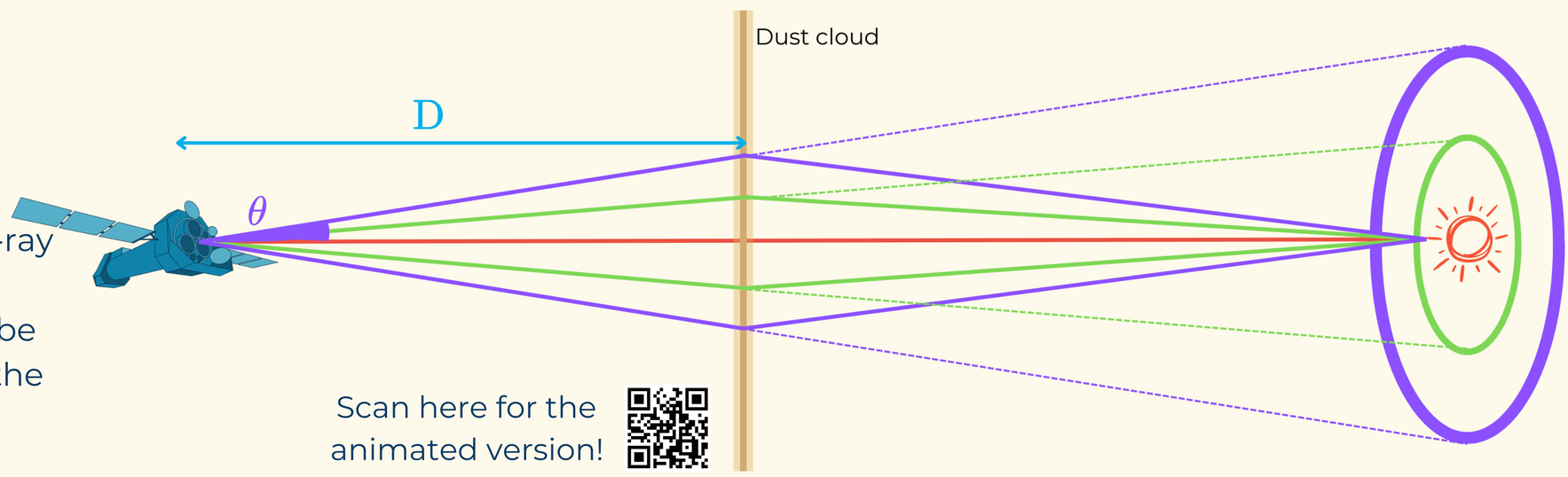
DUST SCATTERING X-RAY RINGS

$$t - t_0 = \theta^2 / 2cD \longrightarrow \theta = \sqrt{\frac{2c(t-t_0)}{D}} \longrightarrow D = 2c(t-t_0)/\theta^2$$

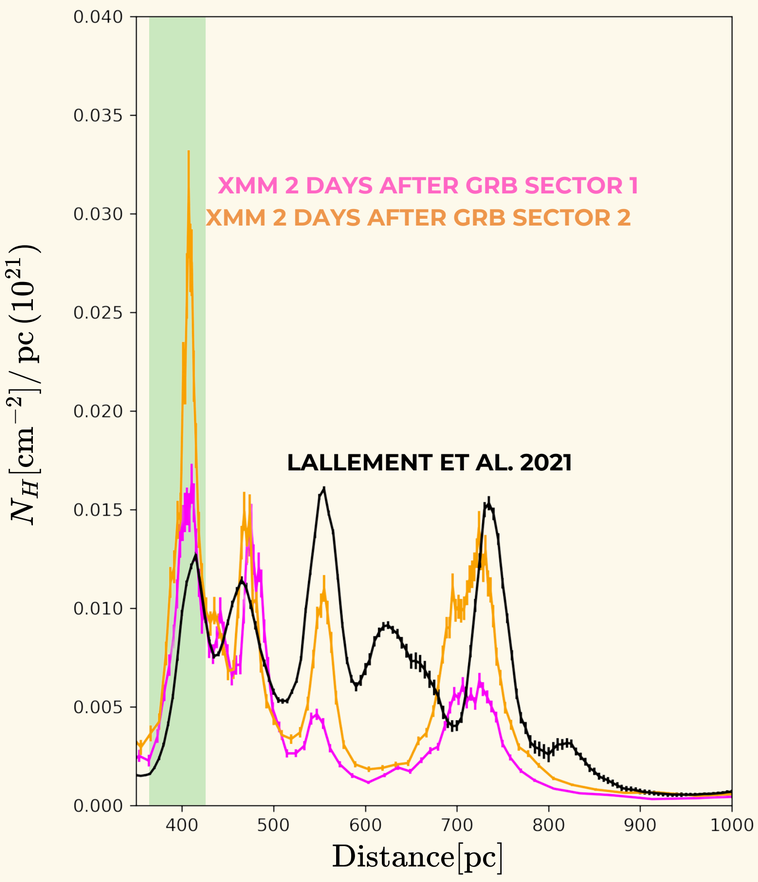
- Dust particles scatter X-ray photons at angles <<1°. Due to its longer path, the scattered radiation has a **time delay** compared to unscattered photons.
- If the source flares and the dust is concentrated in a thin dust cloud, an X-ray **expanding ring** is formed.
- The **distance** (**D**) of the dust cloud can be measured from the ring radius (θ) and the time delay ($t - t_0$).



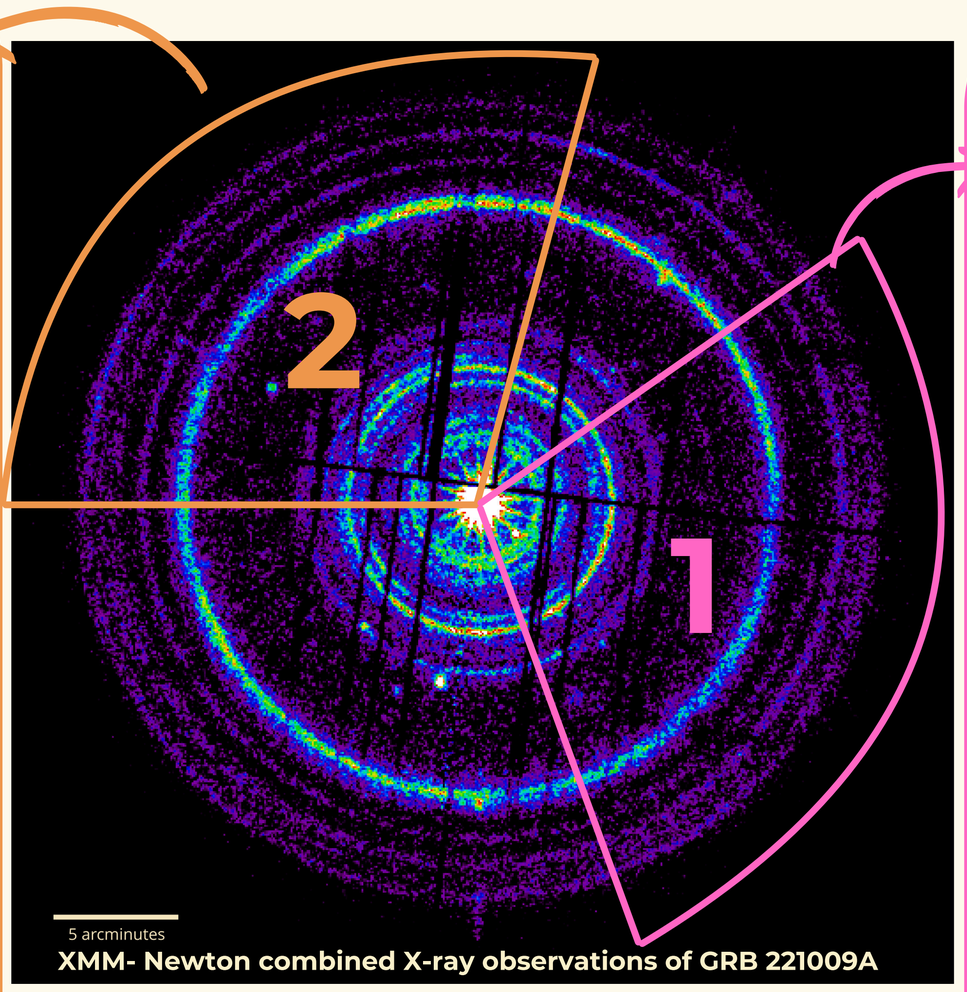
Scan here for the animated version!

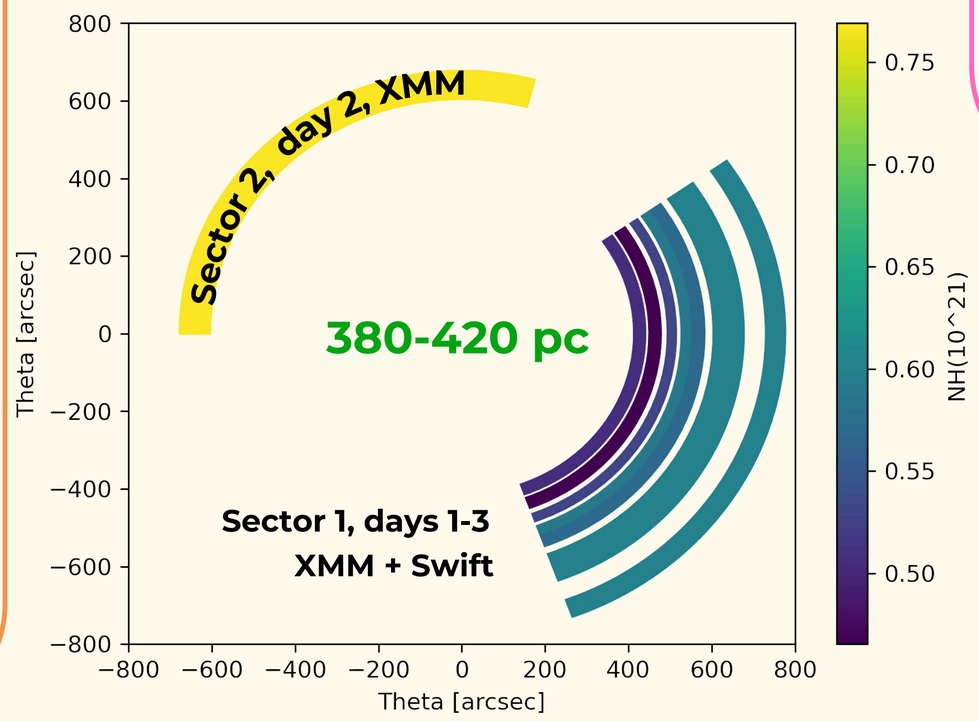
On 2022 October 9 the brightest gamma-ray burst of all time (**GRB 221009A**) was observed **behind the Galactic Plane**. **X-ray rings** were observed with Swift (from Oct 10) and XMM-Newton (on Oct 11 and 14; *Tiengo, Pintore, Vaia et al. 2023*). The **spatial variability** of each X-ray ring allows us to produce a detailed **3D map of the interstellar medium** (*Vaia et al. in prep.*).

Sector 2 is the region with the the largest Galactic **X-ray absorption**. Comparing the dust distribution in the two sectors, we find that most of this excess is due to **denser dust clouds** at 400, 550 and 700 pc.

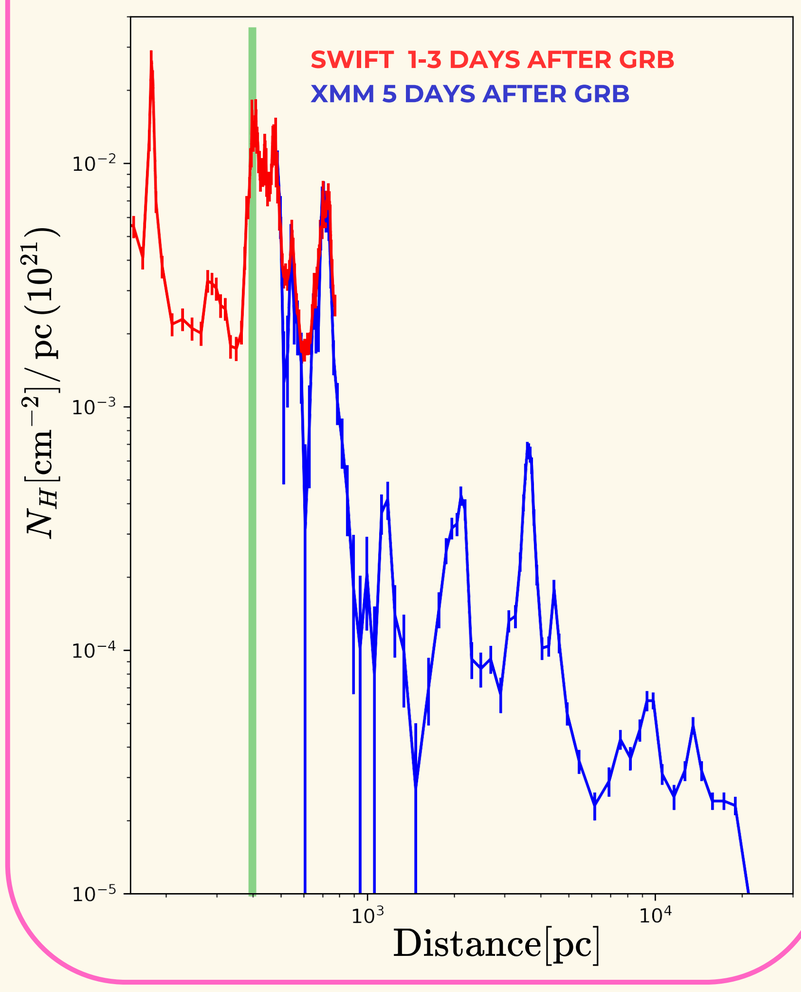


Comparing our dust distributions with the **3D extinction map** by *Lallement et al. (2021)*, most peaks are at consistent distances but their heights are different. This discrepancy is very likely due to the **worse resolution** of the *Lallement et al.* map (>1°) .





Sector 1 is the only region where we can map the dust distribution throughout the **whole Galaxy** (from 0.1 to 20 kpc)



Selecting an interval distance (e.g., **380 - 420 pc**) in different observations we can map the quantity of dust in the corresponding cloud at different **angular radii** (θ) .

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