MPE CWG f2f Meeting

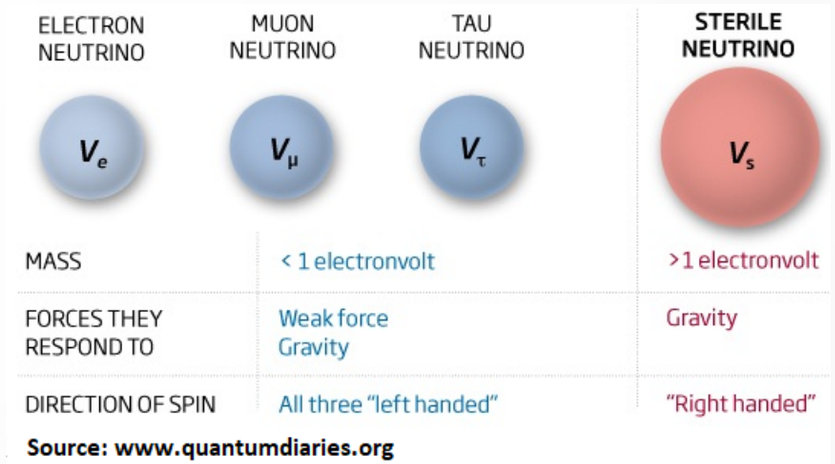
Stacking the spectra of eRASS1 Cluster for the searches of sulfur charge exchange and 3.5 keV line

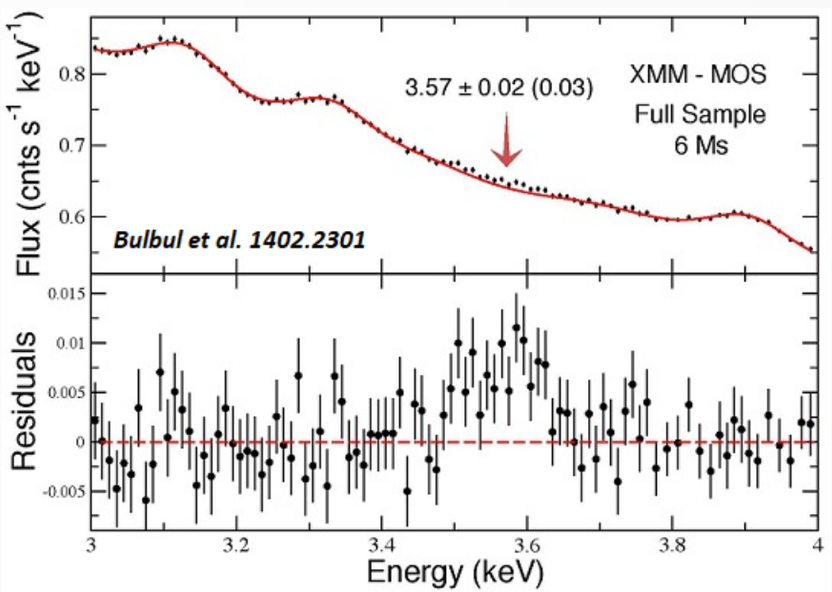
Master thesis (started Nov 2020) - Justo Gonzalez (LMU-USM / ESO)

Supervisors: Esra Bulbul (MPE), Klaus Dolag (LMU-USM)

Status of the 3.5 keV line

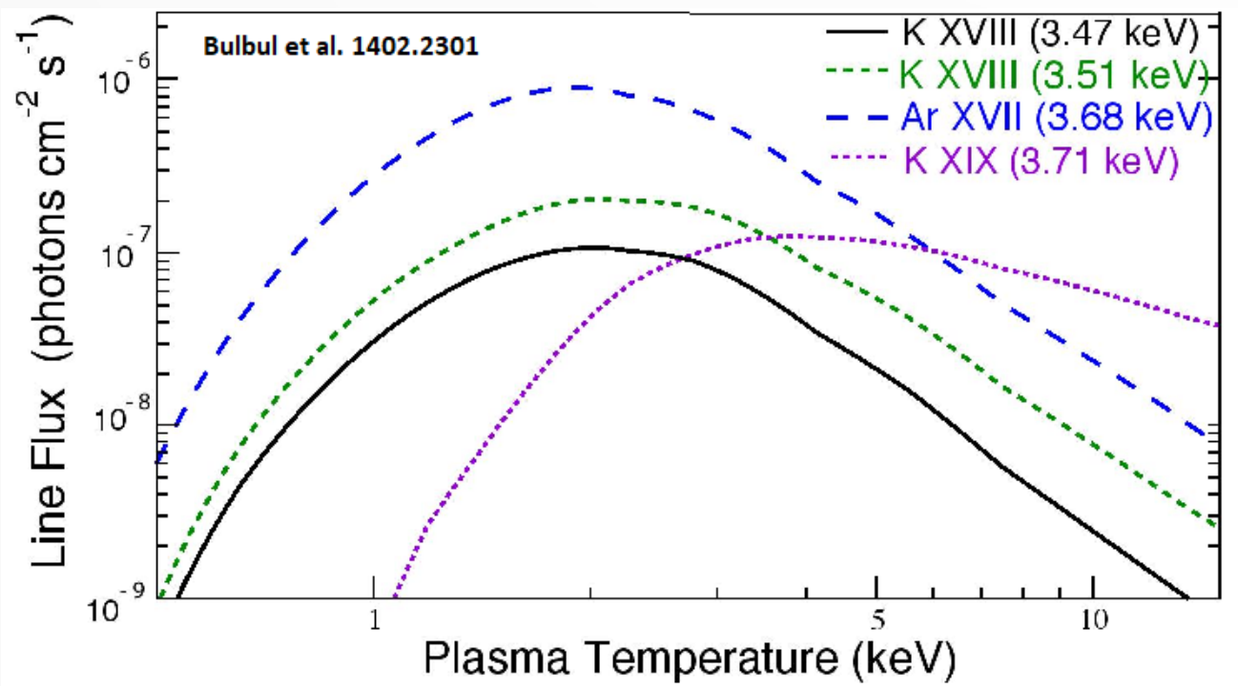
- **Motivation:** Potential Dark Matter candidates such as 'Sterile Neutrino' (right handed, non-interacting version of the neutrino) would decay into a standard model neutrino emitting two X-Ray photons with energy half of the dark matter particle.
- **Technique:** Stacking the spectra of galaxy clusters at different red-shifts allows to reduce significantly the instrumental contamination when the spectra is shifted into the rest frame of the source.
- **Status:**
  - First detection (> 4 sigma) of an unidentified line feature (ULF) at 3.55-3.57 keV applying the stacked spectra technique to XMN-Newton data of 73 galaxy Clusters (z=0.01-0.35) reported by Bulbul+2014.
  - Followed up detections (> 4 sigma) in the Galactic Center and M31 by Boyarsky+2014/2015. However also non-detection reported in the stacked spectra of Galaxies by Anderson+2015.
  - An alternative explanation to a dark matter decay was first proposed by L.Gu+2015. It consists of charge exchange (CX) between bare sulfur ions (S XVI) and neutral hydrogen with a relative velocity of 200 km/s, this line would be located at 3.44keV but the CCD PSF hinders line resolution.

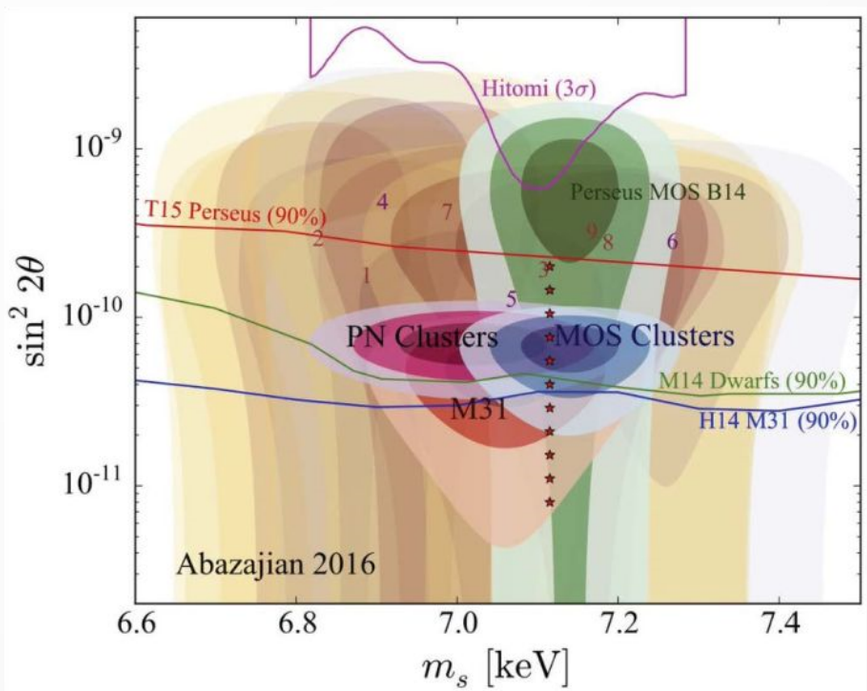




Project goals

- **Goal 1:** Confirm the detection of the 3.55-3.57 keV line accumulating 1 million counts of eROSITA data from Galaxy Clusters.
- **Goal 2:** Study the dependency of the line fluxes on the plasma temperature for the 3.55-3.57 keV line and its neighbor lines (K XVIII 3.47-3.51 keV, Ar XVII 3.68 keV, KXIX 3.71 keV), to clarify if the origin of the 3.55-3.57 keV is Astrophysical.
- **Goal 3:** Assess the impact of including the Sulfur XVI CX 3.44 keV in the model.
- **Goal 4:** Obtain new constrains of the sterile neutrino parameter space (mass - mixing angle / decay time).
- **Goal 5:** Check of the line is still present outside the cluster centers (r > 0.15 R500).





Current status

- Started only 2 weeks ago!
- Currently cross-matching the eRASS1 extended Source catalog from Ang Liu with the existing X-Ray catalogs: MCXC (Piffaretti et al., 2011), SPT (Bocquet et al. 2019), ACT (Hilton et al. 2020), to obtain R500 in order to extract the relevant spectra from each object.
- Want to obtain a list of clusters that accumulate up to 1 million counts, spanning a red-shift range 0.01-0.35, binned them per Tx
- Then extracting the data and processing will follow