Axion Quark Nuggets: A Recipe for a Glowing Milky Way?

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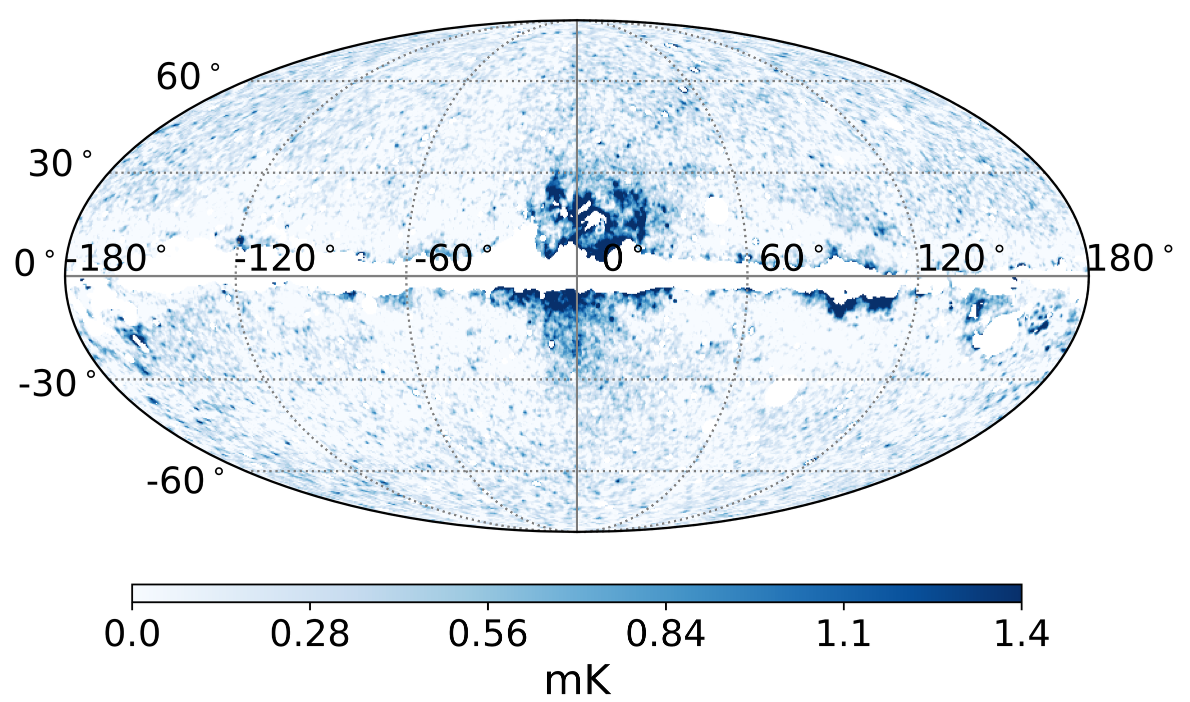
References

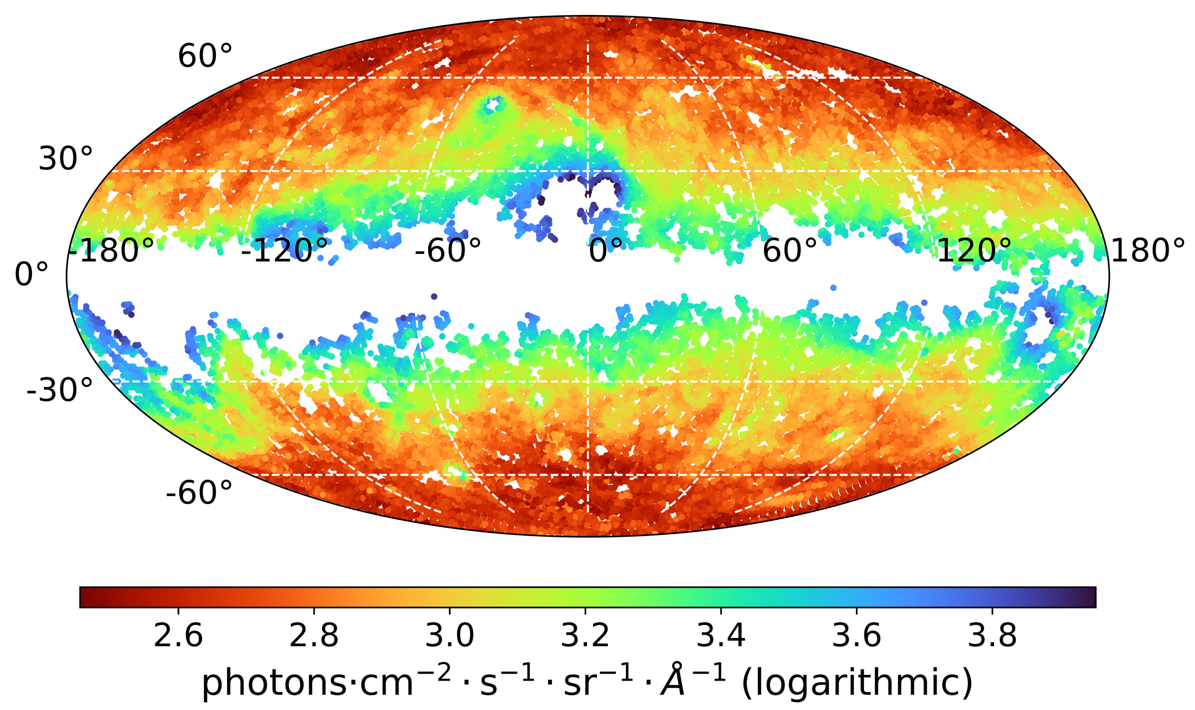
Observation

The **WMAP** and **GALEX** telescopes made full-sky observations in radio (23-94 GHz) and FUV (1350–1750 Å) respectively.

In both observations, excesses in Galactic radiation were identified, the source(s) of which remain unexplained[1]. For FUV, UV-emitting stars have an asymmetry that is not matched by the symmetric background excess[2].



WMAP "haze" K-band (33 GHz), full-sky.



GALEX FUV diffuse background.

Implementation

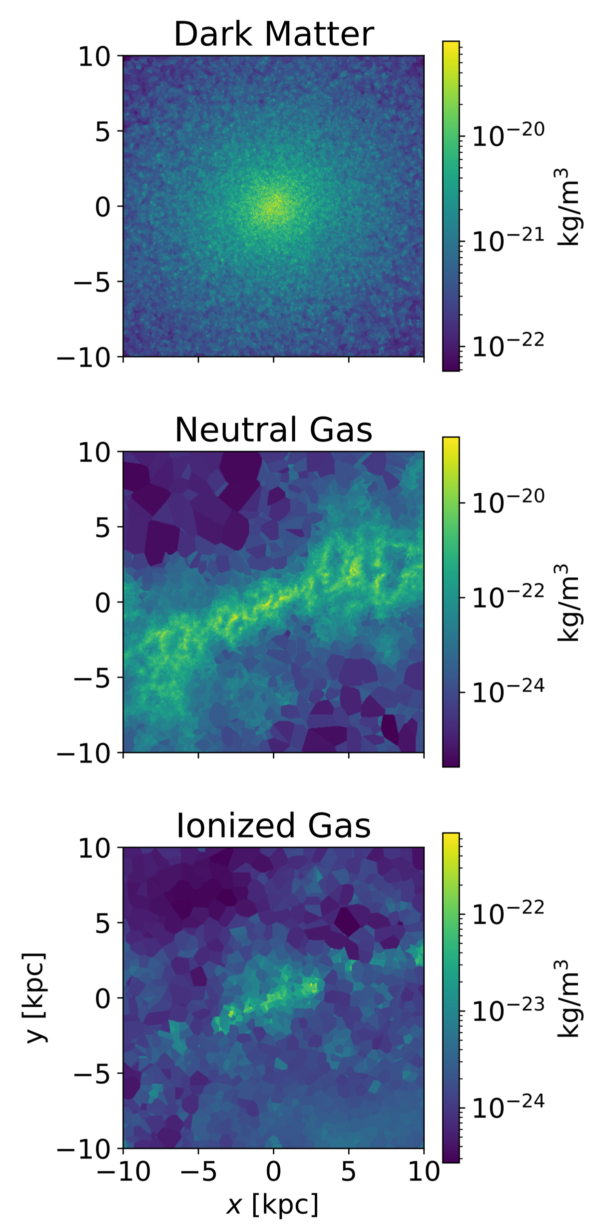
Goal: **Simulate** AQN annihilation emissions in the Milky Way, **compare** with WMAP haze and GALEX excess.

An AQN's **spectral surface emissivity** from an annihilation is described analytically. From this the local **spectral spatial emissivity** from AQNs in a volume element can be obtained and then integrated along sightlines.

There is a dependence on the **local baryon density** through the AQN temperature, and on the **dark matter density**.

First, **radially symmetric analytical models** are used: generalized NFW for dark matter[6], fits of Milky Way-like galaxy simulations for gas[7].

Now, the **local densities** from Milky Way-like galaxy simulations are being used directly (FIRE m12i[8]). On the right, **discrete Voronoi tessellation** was used to convert particle information into density fields, ready for computation.



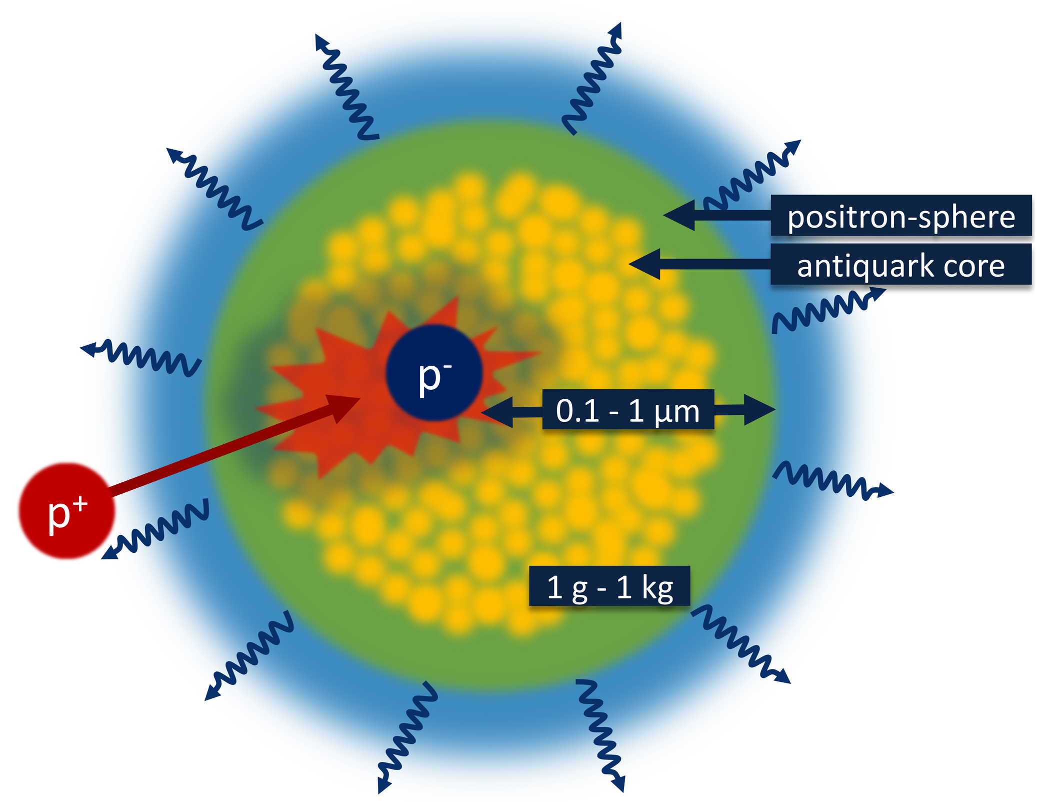
Theory

Axion quark nuggets (AQNs) are a proposed dark matter candidate in the form of large composite objects of nuclear density. They exist in both **matter** and **antimatter** variants[3].

Direct observation is highly improbable due to their **large mass** and very **low number density**.

Baryons (mainly free protons) can collide with antimatter AQNs and **annihilate** with the antiquarks in the core.

Part of the radiated spectrum may explain these observed mysterious excesses[4,5].

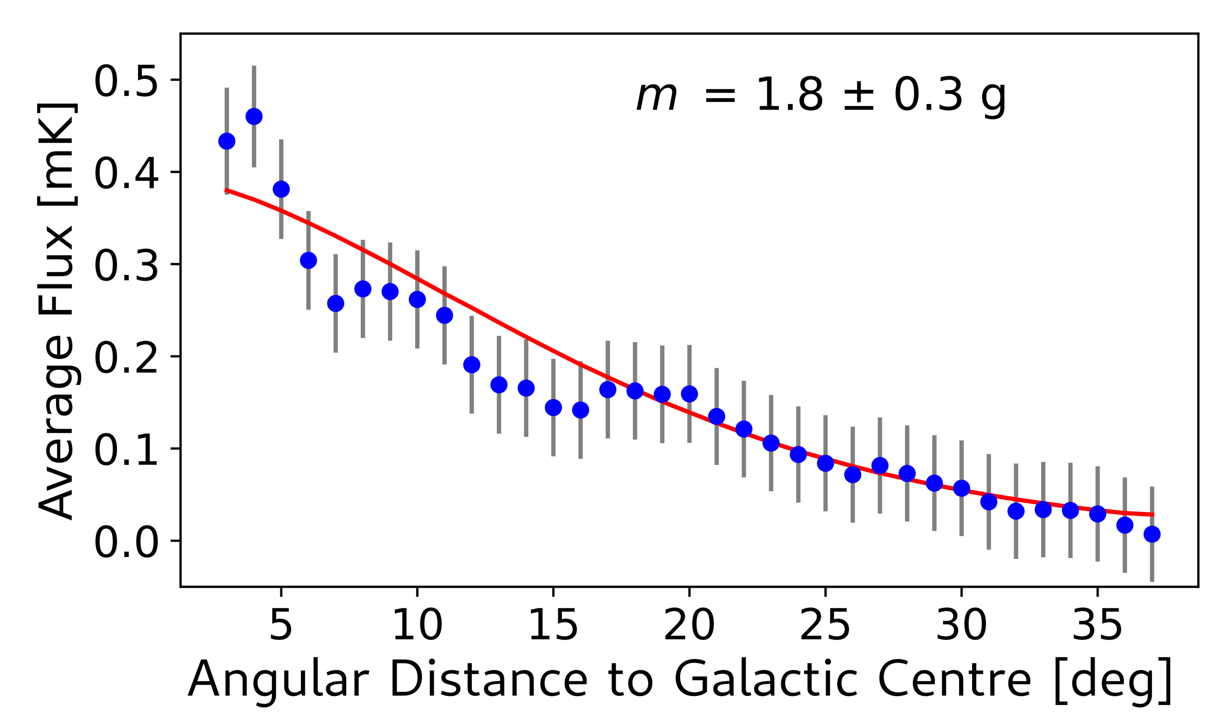


Proton annihilation with antinugget. Antiquark core in color superconducting phase (yellow), inside a positron-sphere (green). A portion of the 2 GeV of available energy is thermalized, heating the positron-sphere, causing it to radiate in a broadband radiation spectrum.

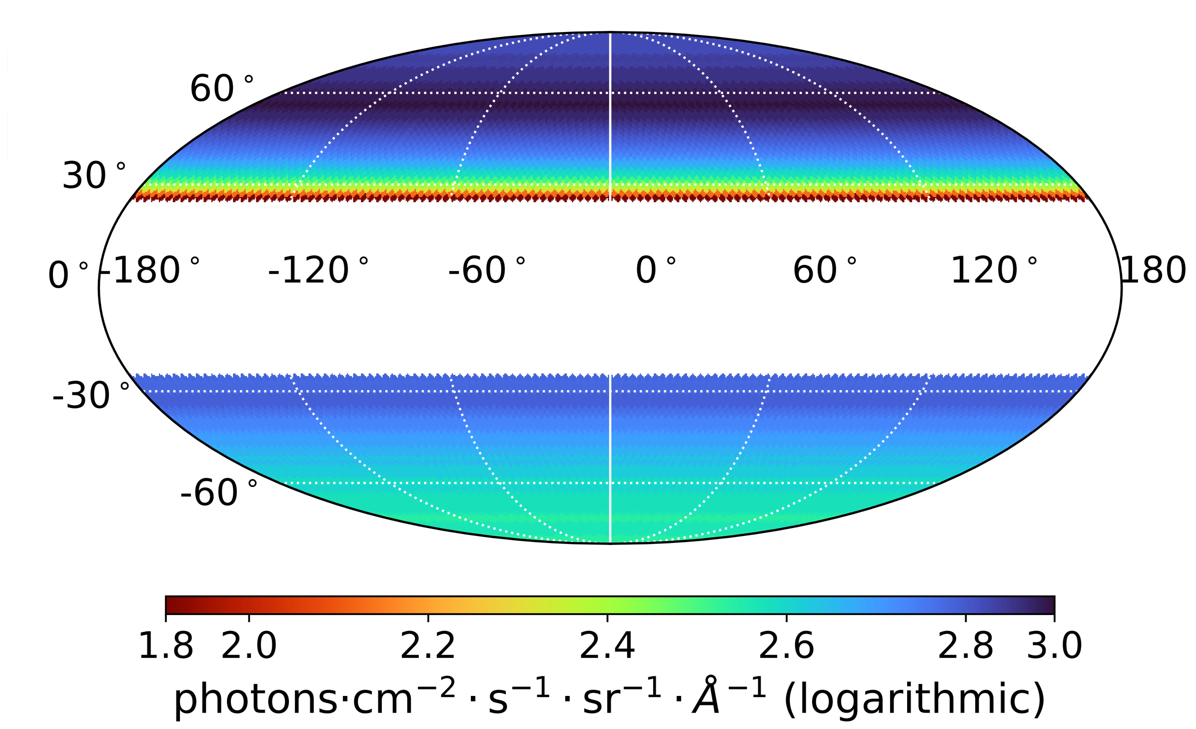
Results

Initial results show a **potential match in signal amplitude and distribution** in radio[9]. For FUV, Local density computations need to be improved by accounting for scattering and absorption effects.

The AQN model may have the unique ability to **explain multiple observed Galactic excesses within the same dark matter framework**.



Radio AQN annihilation flux and WMAP haze flux. Results from MCMC analysis.



FUV AQN annihilation flux using radially averaged data from FIRE m12i simulation.

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