



The Gamma-ray Emission of Ultrafast Outflows

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Abstract

Massive black holes at the centers of galaxies can launch powerful wide-angle winds, which if sustained over time can unbind the gas from the stellar bulges of galaxies. Propagating through the galaxy, the wind should interact with the interstellar medium creating a strong shock, similar to those observed in supernovae explosions, which is able to accelerate charged particles to high energies. Here we report the Fermi Large Area Telescope detection of gamma-ray emission from these shocks in a small sample of galaxies exhibiting ultra-fast outflows. The detection implies that energetic black-hole winds transfer $\sim 0.04\%$ of their mechanical power to gamma rays and that the gamma-ray emission may represent the onset of the wind-host interaction.

Method

We search for the collective sub-threshold emission of 11 galaxies with a UFO selected from the Tombesi et al. (2010, 2012) samples. We adopt a stacking technique derived from Paliya et al. 2019.

Results

The emission from UFOs is significantly detected (5σ), while a control sample yields no signal. We find that the gamma-ray luminosity of UFOs scales with the AGN bolometric luminosity and that the gamma-ray signal originates between 20-300 pc from the SMBH.

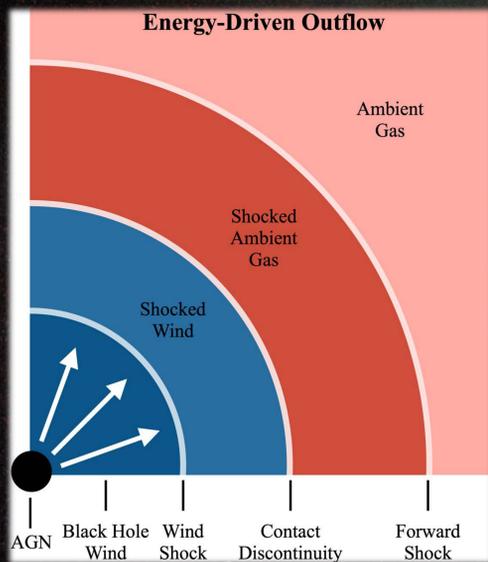
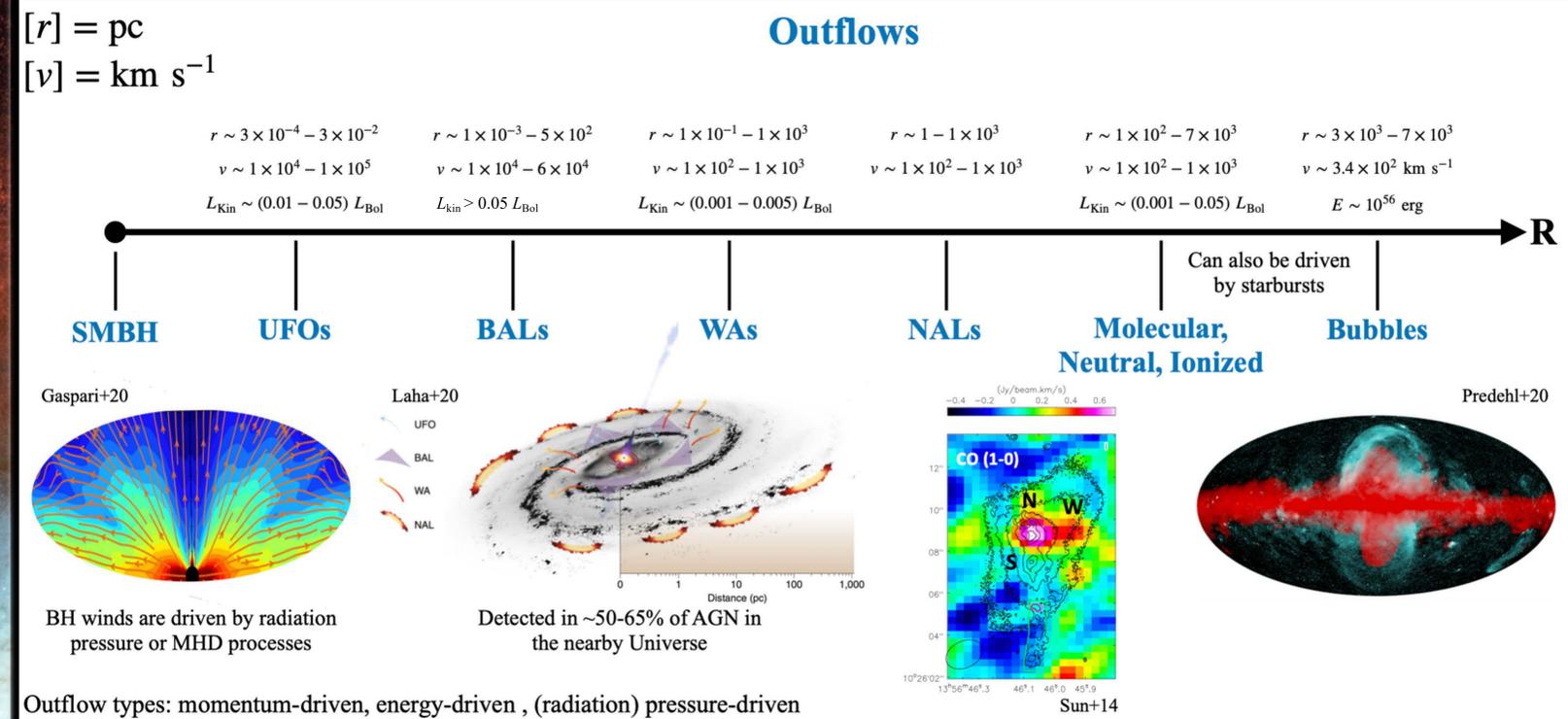


Fig.1: Schematic representation of AGN wind interaction with the interstellar medium

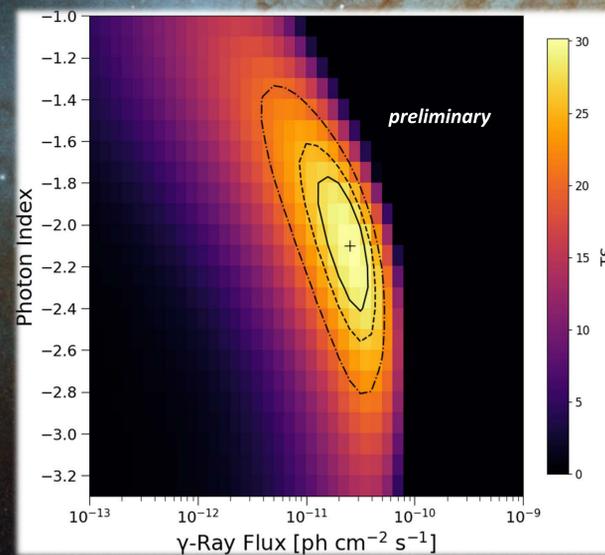


Fig.2: TS profile of the stacked sample of 11 UFOs. TS is related to significance roughly as $n_\sigma \sim \sqrt{TS}$

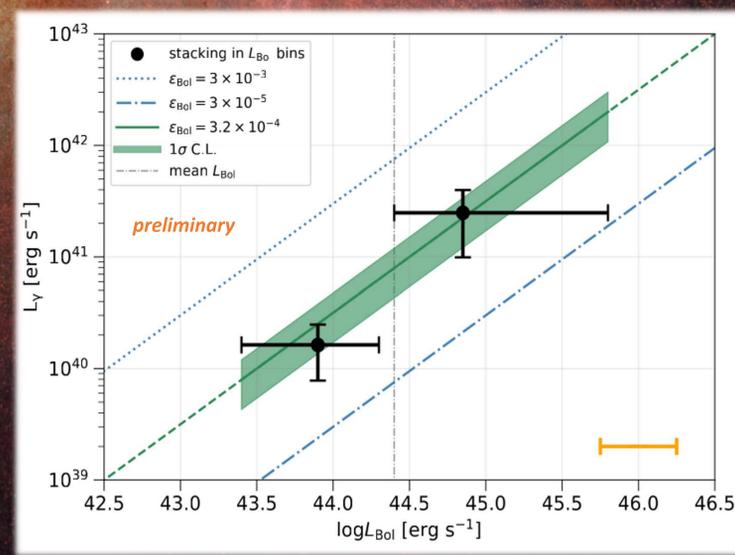


Fig.3: Correlation between the gamma-ray luminosity and AGN bolometric luminosity

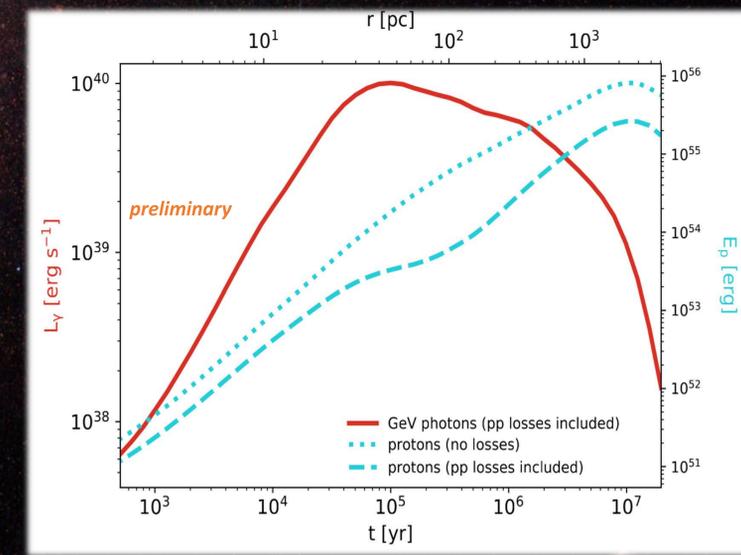


Fig.4: Evolution of the gamma-ray luminosity and energy deposited in cosmic rays as the forward shock moves through the galaxy.