

# An AGN-starburst composite multi-messenger model of NGC 1068

## — Executive Summary —

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We model the non-thermal emission from the inner hundreds of parsecs of NGC 1068 — both starburst *and* AGN (corona) region — to gain an understanding of these source regions and their individual contributions to the non-thermal emission of this object. AGN-starburst composite galaxies are of special interest, as both phenomena on their own are potential sources of the high-energetic cosmic rays, so that they are very promising candidates for the direct detection of high-energy cosmic rays and neutrinos.

To start investigating the different physical processes in these regions, we build a simplified, steady-state two-zone model that accounts for the individual characteristics of both environments and provides first predictions on both starburst and AGN corona emission.

It is finally shown (see Fig. 1) for the case of NGC 1068 that its spectral energy distribution can only be explained if we account for both emission regions: (a) the starburst providing the dominant contribution to the sub-meV radio flux as well as the gamma-ray flux above  $\sim 1$  GeV; and (b) the AGN corona dominating at photon energies in between, leading also to a dominant high-energy neutrino flux that fits to the recent IceCube measurements.

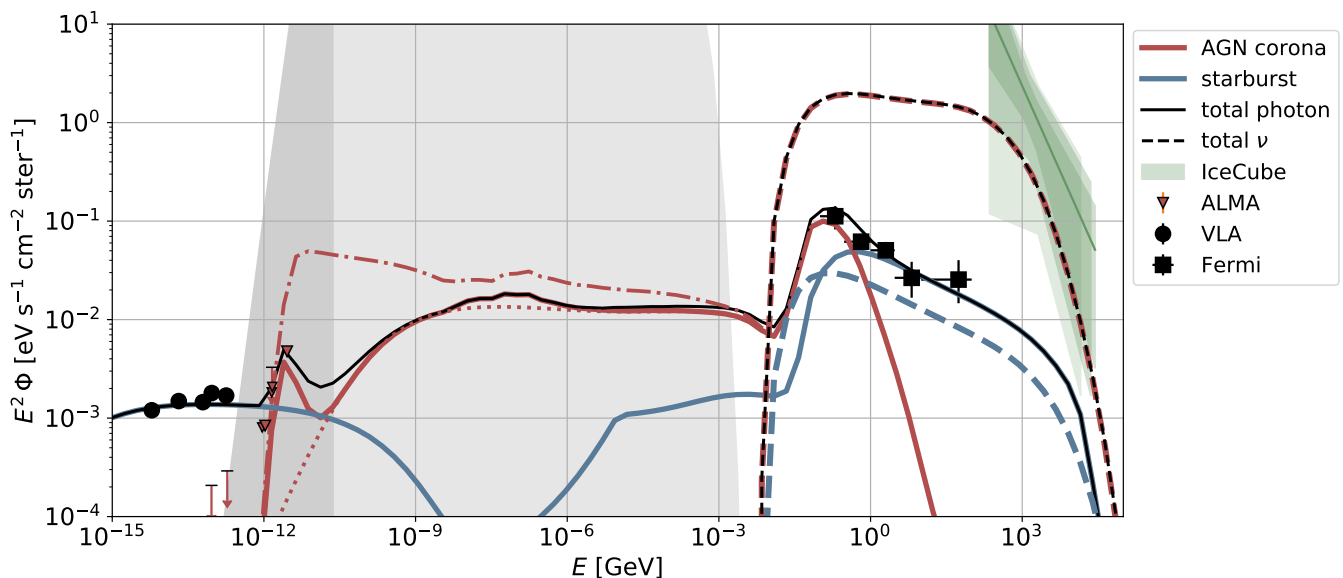


Figure 1: The model predictions of the *photon* (*solid/ dotted/ dash-dotted lines*) and *neutrino* (*dashed lines*) SED of NGC 1068 with respect to the data (small red markers and upper limits refer to a beam size of  $\sim 10$  mas, and large black markers indicate a beam size of  $\gtrsim 10$  as). The light grey area indicates the energy range that is covered by the thermal photon fields (disk- and torus emission as well as Comptonized X-rays of the AGN corona) of the AGN and the dark grey area indicates the thermal IR emission of the starburst region. The red dotted line indicates the total photon SED by the AGN corona in the case of vanishing primary electron (or at least  $E_{\max}^{(e)} \ll 1$  MeV) and the red dash-dotted line indicates the total photon SED by the AGN corona in the case of  $E_{\max}^{(e)} = 100$  MeV.