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Giant cosmic ray halos around M31 and the Milky Way

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Recently, a diffuse emission of 1-100 GeV gamma-rays has been detected from the direction of M31, extending up to ~ 200 kpc from its center.

The interpretation of the extended gamma-ray emission by the escape of cosmic rays produced in the galactic disk or in the galactic center is problematic.

Here we argue that a cosmic ray origin (either leptonic or hadronic) of the gamma-ray emission is possible in the framework of non standard cosmic ray propagation scenarios or is caused by *in situ* particle acceleration in the galaxy's halo. Correspondingly, the halo is powered by the galaxy's nuclear activity or by the accretion of intergalactic gas.

If the formation of cosmic ray halos around galaxies is a common phenomenon, the interactions of cosmic ray protons and nuclei with the circumgalactic gas surrounding Milky Way could be responsible for the isotropic diffuse flux of neutrinos observed by Icecube.

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