



Serbian Astronomical Conference

Search for a connection between IceCube neutrinos and optical polarization in blazars

Ekaterina Shishkina¹, Sergey Savchenko^{1,2}, Daria Morozova¹

¹ Saint Petersburg State University

²CAO RAS (Pulkovo), Russia

Introduction

Blazars are considered likely sources of astrophysical neutrinos. In turn, the polarization of optical synchrotron radiation allows one to trace the configuration of the magnetic field in blazars jets. We consider 4 illustrative cases from a sample of 32 AGNs and examine their multiwavelength behaviour surrounding the IceCube events. We discuss these observations in the context of jet models in which neutrino production may occur either within the regions responsible for the observed optical and γ -ray emission or in a spatially distinct zone.

PKS 0735+178 | IceCube-211208A

An optical EVPA rotation with an amplitude $\Delta\chi = -67^\circ$ ended 5 days prior to the neutrino alert. Contemporaneous optical & γ -ray activity are observed. Mean optical PD over the episode: 8.0%. Mean optical EVPA $107^\circ \pm 4^\circ$ aligns with the inner (<0.35 mas) radio jet PA ($110^\circ \pm 10^\circ$).

Possible scenario (if the association is physical)

This epoch was accompanied by the interaction of two radio knots observed via the VLBI method [1]. This collision could accelerate protons, which in turn could interact with the external photons (possibly from a slower sheath) through $p\gamma$ collisions [2]. Such physical conditions could produce neutrinos during the multiwavelength flares.

Ton 599 (4C +29.45) | IC170527A

Neutrino alert coincides with an optical EVPA rotation with $\Delta\chi = -282^\circ$, while γ -ray activity remains low. Mean PD over the episode (11.5%) is moderate. Mean optical EVPA ($79^\circ \pm 10^\circ$) is nearly perpendicular to the radio jet PA ($10^\circ \pm 4^\circ$).

Possible scenario (if the association is physical)

A disturbance propagating on a curved trajectory could cause an EVPA rotation without simultaneous γ -ray flare. the optical EVPA rotation could trace a disturbance containing a localized neutrino-production site whose electromagnetic emission does not dominate the observed GeV flux.

3C 279 | IC140101A

Dramatic γ -ray flare and enhanced optical activity; optical PD decreased; optical EVPA is mostly stable ($60^\circ \pm 6^\circ$) is offset from the radio jet PA ($-153^\circ \pm 1^\circ$) by approximately 33° .

Possible scenario (if the association is physical)

A subdominant population of accelerated protons could produce neutrinos through $p\gamma$ interactions while electrons dominate the observed optical and γ -ray flare, without requiring a large change in the optical EVPA. Electron injection or enhanced seed-photon density could increase Compton emission without a large EVPA rotation. IXPE observations at another epoch favour a Compton origin for the X-rays [3].

PG 1553+113 | IC200410A

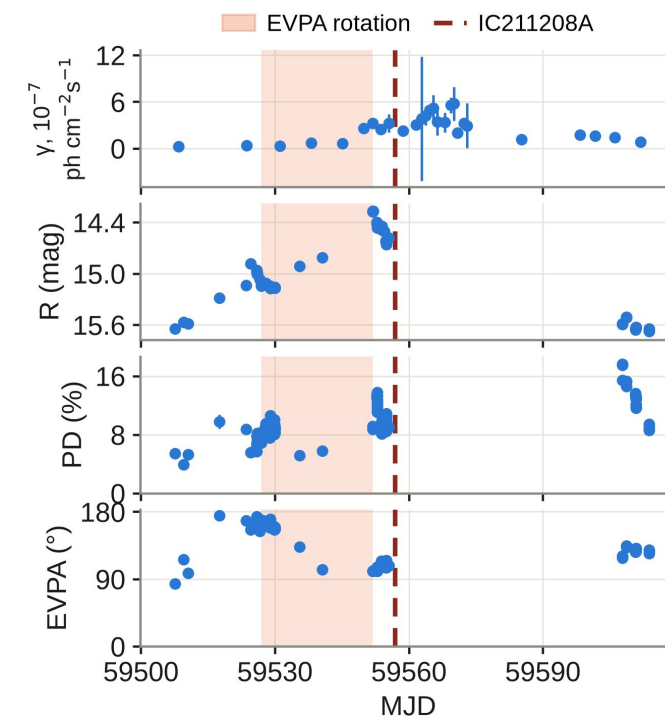
Neutrino alert coincides with an optical EVPA rotation with $\Delta\chi = +154^\circ$, while γ -ray activity remains low. Mean optical EVPA ($53^\circ \pm 19^\circ$) aligns with the radio jet PA ($\sim 50^\circ$).

Possible scenario (if the association is physical)

An independent 2023 campaign found an optical rotation without a matching X-ray rotation [4], motivating partially distinct corresponding emitting regions. Accounting reorganization of the magnetic field structure, neutrinos could originate through $p\gamma$ interactions in a compact region distinct from the dominant optical and GeV emission regions. Thus, a neutrino could be produced without a prominent γ -ray flare.

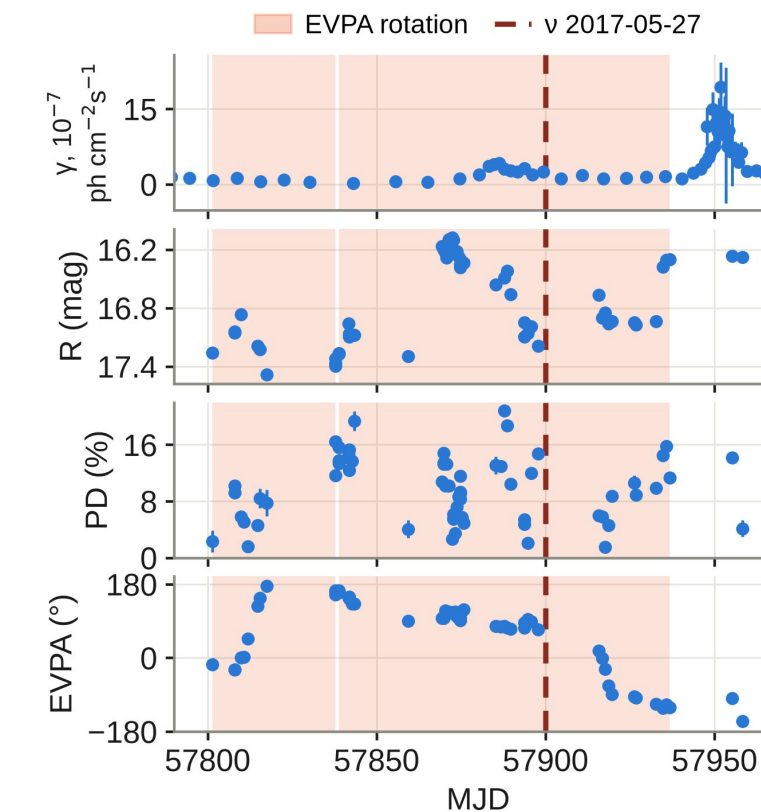
PKS 0735+178 | IceCube-211208A

Flares following an EVPA rotation



Ton 599 (4C +29.45) | IC170527A

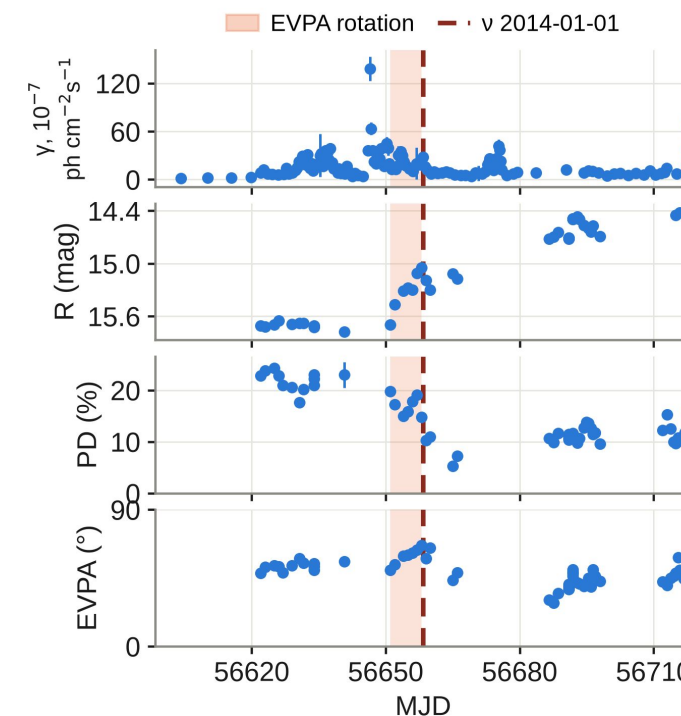
Rotation without a strong γ -ray flare



[1] Morozova et al. 2026, AGES conference proceedings (in press). [2] Prince et al. 2024, MNRAS 527, 8746. [3] Marshall et al. 2024, ApJ 972, 74. [4] Middei et al. 2023, doi:10.3847/2041-8213/acec3e.

3C 279 | IC140101A

γ -ray flare with a quasi-stable EVPA



PG 1553+113 | IC200410A

Low PD during a large EVPA rotation

