

Annual Report

Funding Programme:	Helmholtz Young Investigators Groups
Project ID No.:	VH-NG-1202
Project Title:	Identifying the Sources of High-Energy Neutrinos with Multi-Messenger Observations
Group Leader:	Dr. Anna Franckowiak
Helmholtz Centre:	DESY, Zeuthen
Participating University:	Humboldt University Berlin
Report Period (=Calendar Year):	01/2018-12/2018

1) Group Structure

Please report briefly on the structure and personnel development of your group.

The group consists of two PhD students (Robert Stein since July 2017, Simone Garrappa since February 2018) and two postdocs (Dr. Ludwig Rauch since August 2017 and Dr. Vaidehi Paliya since November 2018).

2) Network

Please describe how you / your research group are integrated within the Helmholtz Centre and the partner university (e.g. as member of committees).

All group members participate actively in the weekly group meeting of the IceCube group and we have a weekly meeting with the supernova cosmology group at Humboldt University, with whom we have a fruitful collaboration on developing software for the optical survey ZTF. Group members participate in DESY outreach events and the PhD students take over teaching responsibility in form of tutoring. The group hosts one master student and one bachelor student from HU Berlin.

3) Satisfaction

How satisfied are you with the general working conditions provided by the Helmholtz Centre / partner university? Is there anything that meets your criticism?

I am very satisfied with the general working conditions provided by DESY and Humboldt University.

4) Scientific Progress / Milestones

How has your work plan progressed? Which important milestones could be achieved during the report period? Is the progress of your work in accordance with original planning or has the work plan been changed?

The work plan is progressing very well. More details are listed below following the structure of the work plan.

WP1 Real-time neutrino analysis

WP1.1 Online event reconstruction and trigger algorithm

Robert Stein and Simone Garrappa are active as IceCube real-time shifters and react to high-energy neutrino alerts quickly. They participate in the development of a new pipeline to process future alerts fully automatically.

WP1.2 Extension of the follow-up observatory network

ASAS-SN regularly observes high-energy neutrino alerts in a fully automated way. A follow-up with ZTF is implemented.

WP2: Discovery and identification of optical transients with ZTF

Ludwig Rauch installed a realtime correlation of IceCube neutrinos and ZTF optical candidates with in the AMPEL software framework in close collaboration with the AMPEL developers at

HU Berlin. First candidates have been spectroscopically classified. Ludwig Rauch works closely together with a team at Caltech to compile a redshift complete catalog of optical transients. Ludwig presented his work at several conferences (TeVPA in Berlin, VLVnT in Russia). He will visit Caltech in April as part of a NSF funded GROWTH fellowship.

WP3 Stacking analysis using archival multi-wavelength data sets

Robert Stein has developed a tool for time-dependent neutrino stacking analysis, which is more powerful compared to the SkyLab tool used in the IceCube collaboration for time-integrated analyses. The tool is also in use by other members of the IceCube group at DESY.

WP3.1 Search for neutrinos from SNe

Robert Stein worked together with a former PhD student of the IceCube group on the first publication of a supernova stacking analysis. The resulting paper is currently in collaboration review. The results of a follow-up of a high-energy IceCube neutrino with the PanSTARRs optical telescope resulted in the detection of a supernova. The results were submitted to the A&A journal.

WP3.2 Search for neutrinos from AGN flares

Simone Garrappa searched for gamma-ray sources detected by the Fermi-LAT in coincidence with high-energy IceCube neutrinos. One coincidence was found with a gamma-ray blazar, which was showing moderate flaring activity during the neutrino arrival. We have studied the multi-wavelength behavior of this source. This analysis resulted in a multi-collaboration paper, which was submitted to ApJ and presented at TeVPA in Berlin. Vaidehi Paliya and Simone Garrappa are working on a gamma-ray light curve production pipeline to search for neutrinos from gamma-ray blazars in a systematic way.

WP3.3 Search for neutrinos from TDEs

Robert Stein compiled a TDE catalog and applied his tool to search for neutrinos from those sources. The analysis was reviewed by the IceCube collaboration and unblinded. No excess of neutrinos from TDEs was found and Robert Stein calculated upper limits on the neutrino luminosity of those sources. A paper draft summarizing the results is in an advanced stage. Preliminary results were presented at TeVPA in Berlin.

5) Financial Plan / Time Schedule

Can you comply with the financial plan and time schedule or do you see a need for adjustment?

I can comply with the financial plan and time schedule.

6) Status

Do you hold a joint Junior Professorship or a W2/W3 Professorship? Do you aim for such a position? What is the status of your negotiations in this respect?

I do currently not hold a professorship position. I am interested in a Junior Professorship at HU or TU.

7) Teaching Activities of the Group Leader

The group leader taught the following courses at HU Berlin:
SS2018 "Astroparticle Physics"
WS2018/19 "Kern- und Teilchenphysik"

8) Publications of the Group

"Multimessenger observations of a flaring blazar coincident with high-energy neutrino IceCube-170922A", The IceCube Collaboration, *Fermi*-LAT, *MAGIC*, *AGILE*, *ASAS-SN*, *HAWC*, *H.E.S.S.*, *INTEGRAL*, Kanata, Kiso, Kapteyn, Liverpool Telescope, Subaru, *Swift*/*NuSTAR*, *VERITAS*, *VLA/17B-403* teams, *Science*, 2018, 361, 6398, eaat1378

“Investigation of two *Fermi*-LAT gamma-ray blazars coincident with high-energy neutrinos detected by IceCube”, submitted to ApJ, arXiv:1901.10806, S. Garrappa, S. Buson, A. Franckowiak (*Fermi*-LAT), IceCube, ASAS-SN Collaborations

“A search for transient optical counterparts to high-energy IceCube neutrinos with Pan-STARRS1”, submitted to A&A, arXiv:1901.11080, Pan-STARRs and IceCube Collaborations

“Eddington Bias for Cosmic Neutrino Sources”, N. Strotjohann, M. Kowalski, A. Franckowiak, A&A 622, L9, 2019.

“High-Energy Emission from Interacting Supernovae: New Constraints on Cosmic-Ray Acceleration in Dense Circumstellar Environments”, K. Murase, A. Franckowiak, K. Maeda, R. Margutti, J. F. Beacom, arXiv:1807.01460, accepted by ApJ, 2019.

“Constraints on minute-scale transient astrophysical neutrino sources”, M.G. Aartsen et al. (the IceCube Collaboration), PRL 122, 051102, 2019. Main author and analyzer: Nora Strotjohann (PhD student co-supervised by A. Franckowiak)

9) External Funding

No external funding was received

10) Patent Applications

No. of pending/granted patents

Does not apply.

11) Awards received by Group Members / Professorship Appointments offered to Group Leader

The group leader was offered the IceCube analysis coordinator position, which will start in May 2019. Vaidehi Paliya received an award for the best PhD in astronomy in India and Ludwig Rauch received an award for the best PhD at University of Heidelberg. Vaidehi Paliya was appointed *Fermi*-LAT AGN group coordinator.