THUNDERSTORMS & ELEMENTARY PARTICLE ACCELERATION

GENERAL INFORMATION:

TIME FRAME: October 17-20, 2022

LOCATION:

Prague, Czechia.

SYMPOSIUM WEBSITE:

http://crd.yerphi.am/TEPA_2022

ORGANIZERS:

Cosmic Ray Division of Yerevan Physics Institute, Armenia
Research Centre of Cosmic Rays and Radiation Events in Atmosphere (CRREAT), Nuclear Physics Institute of the CAS, Czechia

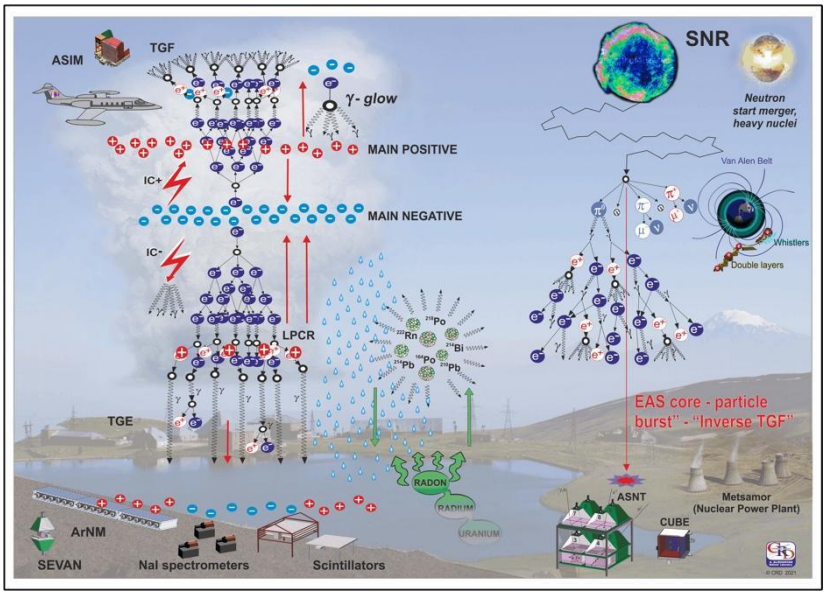

Figure 1. Extragalactic, Galactic and atmospheric sources of secondary cosmic rays registered on the Earth's surface and in the space

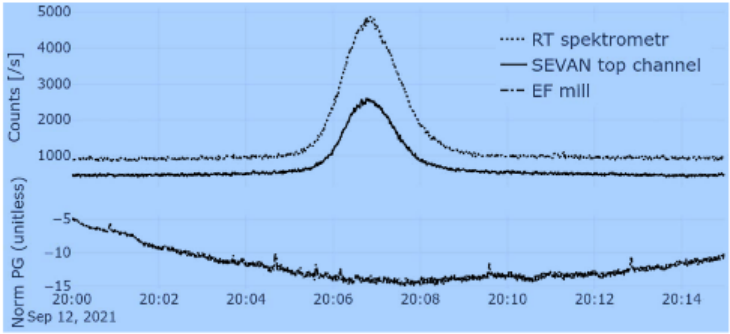

Figure 2. Counts per second registred by the RT-56 (dots), upper channel of SEVAN (black solid line). Normalised potential data from EFM-100 and normalized potential gradient.

INTERNATIONAL ADVISORY COMMITTEE:

Ashot Chilingarian, Yerevan Physics Institute, Armenia (Chair)
Ondrej Ploc, CRREAT head, Nuclear Physics Institute of the CAS, Czechia (Co-chair)
Eric Benton, Oklahoma University, USA
Joseph Dwyer, Department of Physics University of New Hampshire, USA
Gerald Fishman, NASA-Marshall Space Flight Center, Huntsville, AL, USA
Hartmut Gemmeke, Karlsruhe Institute of Technology, Germany
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Tatsuo Torii, Japan Atomic Energy Agency, Tsuruga, Japan
Harufumi Tsuchiya, Cosmic Radiation Laboratory, Riken, Japan.

BACKGROUND:

The new emerging field of high-energy atmospheric physics (HEAP) has been enriched recently by important observations of particle fluxes on Earth's surface, in the troposphere, and in space. HEAP presently includes three main types of measurements: Terrestrial Gamma Ray Flashes (TGFs) – brief bursts of gamma radiation (sometimes also electrons and positrons) registered by orbiting gamma ray space observatories, Thunderstorm ground enhancements (TGEs) – short and prolonged electron and gamma ray fluxes registered on the Earth's surface, and Gamma glows – gamma ray bursts observed in the thunderclouds by instrumentation on balloons and aircraft.

Recently some authors add inverse TGFs – a intense particle bursts of millisecond duration registered on the Earth's surface. The central engine initiating the TGEs and TGFs is believed to be the Relativistic Runaway Electron Avalanches (RREA), which accelerates seed electrons from an ambient population of cosmic rays (CR) in large-scale thundercloud electric fields. Observations of numerous TGEs by Japanese, Russian, Armenian, Czech, Chinese, Bulgarian and Slovakian groups prove that RREA is a robust mechanism for electron acceleration and multiplication. The origin of gamma glows can be also the modification of electron energy spectrum (MOS process) in the atmospheric electric field leading to additional gamma ray radiation. The hypothesis of the "lightning origin" of inverse TGFs is still under debate. TGE electron and gamma ray energy spectra give new clues for recovering the vertical profile of the atmospheric electric field and for testing models of electron acceleration in the atmosphere. Models using GEANT4 and CORSIKA codes confirm in-situ measurements of electron and gamma ray energy spectra at Aragats. Numerous observations of TGEs made on Aragats during the past 13 years can be widely used for the validation of models aimed to explain TGF phenomena. The CRREAT project is making good progress in developing instrumentation for the comprehensive measurements of the particle fluxes, lightning monitoring with fast cameras and various atmospheric parameters, including radar measurements of the hydrometeor evolution during storms. Many questions about thundercloud electrification and discharge mechanisms, lightning initiation, propagation and attachment processes, the global electrical circuit, and transient luminous events do not have yet a commonly accepted explanation. The estimated

horizontal profile of the atmospheric electric field, that emerges during thunderstorms is still badly understood. The estimate of the size of the particle emitting region in the thundercloud, made a decade ago by Japanese and Armenian physicists (≈1 km radii) seen to be largely undervalued. Enigmatic light glows observed on Aragats during TGEs still await explanation. The new view of thunderclouds as media full of radiation can help to establish a comprehensive theory of cloud electrification and estimate the possible role of cloud radiation on climate change. The influence of the electrifying atmosphere on the fluxes of electrons and other charged particles can be important for experiments registering very-high-energy photons (Atmospheric Cherenkov telescopes) or electrons and hadrons (Surface arrays registering Extensive Air Showers). The TEPA meeting provides an opportunity for scientists to discuss the current ideas and exploit synergies between Atmospheric and Cosmic ray physics.

STRUCTURE OF THE SYMPOSIUM:

We anticipate the following sessions:

1. Multivariate observations of particles and electric fields
2. Instrumentation
3. Models of atmosphere electrification and solar modulation
4. Radiation research at observatories in Europe and winter thunderstorms in Japan

We plan also discussions on the most intriguing problems of high-energy physics in the atmosphere and on possible directions for the advancement of collaborative studies.

Topics to be covered during oral and poster sessions:

- Energy spectra of electrons and gamma rays measured on the earth's surface, in the atmosphere and in the space; their relation to the strength of the electric field;
- Possible relations of the Solar activity and space weather to high-energy physics processes in the atmosphere;
- Registration of wide- and narrowband radio emissions produced by atmospheric discharges and particle fluxes;
- Lightning initiation and its relation to particle fluxes originated in thunderclouds;
- Radionuclide, neutron, and positron production during thunderstorms;
- SEVAN particle detector network as a tool for the TGE research;
- Methods of remote sensing of thundercloud charge structure and atmospheric electric fields;
- Lightning monitoring with fast cameras;
- Abrupt termination of the particle flux by the lightning flash;
- Precise electronics for the high-energy atmospheric research

PROGRAM OF TEPA-2022

Monday, 17 October

9:00 – 10:00 ***Registration*** in Department of Radiation Dosimetry, Nuclear Physics Institute of the CAS, Na Truhlarce 39/64, Prague

10:00 – 11:15 ***Opening Ceremony****, welcome talks, snacks, excursion*

Session 1: Multivariate observations of particles and electric fields

Chairperson: Johannes Knapp

11:15 – 12:00 ***A. Chilingarian*** Modulation effects posed by strong atmospheric electric fields of the fluxes of secondary cosmic rays

12:00 – 12:45 **O. Ploc** General notes about the CRREAT project

13:00 – 14:30 ***Lunch***

Session 1: *Multivariate observations of particles and electric fields*

Chairperson: Martin Kákona

15:00 – 15:30 ***F. Trompier*** Measurements of doses associated with TGF by permanent monitoring on-board commercial aircraft

15:30 – 16:00 ***J. Šlegl*** Winter Thunderstorm Ground Enhancement on Milesovka hill

16:00 – 16:30 ***J. Chum*** Significant TGEs on Lomnický Štít

16:30 – 17:00 ***I. Kolmašová*** Electromagnetic measurements and meteorological observations linked to Thunderstorm Ground Enhancements registered at the Milešovka Mt. observatory in Czechia

17:00 – 17:30 ***Coffee break***

17:30 – 18:30 **ASEC board meeting**

Tuesday, 18 October

Session 2**:** Instrumentation

Chairperson: M. Sommer

9:00 – 9:30 ***M. Sommer*** Neutron detector based on liquid scintillator for measurement of neutrons generated by photonuclear reactions during Terrestrial Gamma Ray Flashes

9:30 – 10:00 ***I. Ambrožová*** Monitoring of ionizing radiation during thunderstorms in forests in Sumava using standalone device GEODOS

10:00 - 10:30 ***M. Kákona*** Thunderstorm chasing using measuring cars equipped with multiple sensors

10:30 - 11:00 ***Coffee break***

11:00 – 11:30 ***R. Dvořák*** Three-dimensional reconstruction of a lightning strikes from multiple high-speed cameras

11:30 – 12:00 ***M. Lužová*** Directional measurements of charged particles in the atmosphere with silicon strip detectors based on PH32 chip technology

12:00 – 12:30 ***Y. Ruban*** Investigation of activation of soil and other samples by thunderstorm radiation

12:30 – 13:00 ***J. Kákona*** Measurement of the Regener-Pfotzer maximum using TF-ATMON

13:30 – 15:00 ***Lunch***

Session 3: Models of atmosphere electrification and solar modulation

Chairperson: J. Popova

15:00 - 15:30 ***M. Walter*** First results of two cosmic particle detectors installed at the UFS Zugspitze and future plans with a SEVAN-light detector

15:30 – 16:00 **T. Karapetyan** Status of the East-European SEVAN network and planned modernizations

16:00 – 16:30 **B. Sargsyan** Modulation effects posed by strong atmospheric electric fields of the fluxes of secondary cosmic rays

16:30 – 17:00 ***Coffee break***

17:00 – 19:30 **Cultural excursion**: Walk on the King's Road Prague

20:00 Conference dinner

Wednesday, 19 October

10:00 -16:00 Conference excursion to Milesovka observatory

Thursday, 20 October

Session 4: Radiation research at observatories in Europe and winter thunderstorms in Japan

Chairperson: J. Šlegl

9:00 – 9:30 ***H. Martoyan*** Forbush decreased observed by nodes of SEVAN East-European particle detector network on November 2021

9:30 – 10:00 ***L. Sihver*** Ionizing Radiation Dose Levels from TGFs and TGEs at Aviation Altitudes

10:00 – 10:30 ***Razmik Mirzoyan*** Recent major results in gamma-ray astrophysics, with emphasis on extending sensitivity to lowest and highest energies

10:30 – 11:00 ***Coffee break***

11:00 – 11:30 ***Y. Wada*** Catalog analysis of gamma-ray glows in winter thunderstorms of Japan

11:30 – 12:00 ***T. Enoto*** Citizen science observation campaign of gamma-ray glows from winter thunderstorms in Japan

12:00 – 12:30 ***Discussion:*** *TGE physics and atmospheric electric field*

12:30 – 12:45 ***Closing ceremony***

13:00 – 14:00 ***Lunch***

14:30 – 16:30 Experiment at Microcrotron: capturing the Lichtenberg figures