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Review of the doctoral thesis by Mgr. Radomír Šmída, entitled "Cosmic-Ray Physics with the Pierre Auger Observatory"

The doctoral thesis by Mgr. Radomír Šmída concerns the experimental study of ultra-high energy cosmic rays. The origin of cosmic rays with these extreme energies continues to be one of the most important problems in present-day astrophysics. Explaining it requires obtaining precise data on cosmic ray composition and energy spectrum, as well as the distribution of arrival directions.

The ultra-high energy cosmic rays may be studied experimentally only through detection of extensive air showers, which they initiate in the atmosphere. Due to low cosmic ray flux at these energies, very large detector systems, like the Pierre Auger Observatory are needed to efficiently collect the experimental data. Mgr. Radomír Šmída is a member of the Pierre Auger Collaboration and his doctoral thesis is a part of the efforts necessary to build and operate the Observatory.

The dissertation being reviewed is written in English. It contains 131 pages including figures, tables and the bibliography of 113 items. The text is divided into 11 chapters. A review of cosmic ray properties and the discussion of candidate sources is presented in Chapters 1 and 2. The author's own studies of propagation of ultra-high energy cosmic rays in the Galaxy are discussed in Chapter 3: several models of the galactic magnetic field are used to test the relation between the observed distribution of cosmic ray arrival directions and the positions of the prospective sources on the sky. Next, in Chapters 4 and 5 the Pierre Auger Observatory is described, along with the main scientific results obtained so far. The rest of the thesis contains the Author's own results on studies of association of cosmic rays with gamma-ray bursts (in Chapter 6), on the performance of the fluorescence detector of the Pierre Auger Observatory (Chapter 7) and on detailed studies of the signals recorded in photomultipliers of the Pierre Auger Observatory fluorescence detector (Chapters 8-10). Finally, the conclusions are found in Chapter 11.

Among the original results of the dissertation, one should mention calculation of the so-called uptime and downtime of the Auger fluorescence detector. These are vital parts of the procedure to determine the energy spectrum of cosmic rays. The author has detected the interference of the lidars, used to monitor the atmosphere at the Auger Observatory, into data acquisition in the fluorescence telescopes. Thanks to this observation, the scheme of atmosphere monitoring at the Observatory was modified, limiting considerably the detector dead time.

The author's analysis of the night-sky brightness, as recorded in the fluorescence detector, revealed a considerable fraction of the telescope run time with relatively high background light. This result prompted the Auger Collaboration to impose a limit on the background light tolerated during data taking. We note that the photomultiplier sensitivity decreases with the accumulated charge, so that a high background leads to premature wear of

the photomultiplier and affects the detector calibration. Mgr. Radomír Šmída thus contributed considerably to maintaining precision and longevity of the detectors. In fact, a subsequent analysis done by Mgr. Šmída showed the considerable reduction of the rate of the photomultiplier wear. These difficult analyses required a great skill and ingenuity in data analysis.

Studies of cosmic ray propagation in the galactic magnetic fields, done by the author, showed that out of charged particles, only high energy protons can travel through the Galaxy, being deflected by only a few degrees. This indicates that the cosmic ray correlation with active galactic nuclei, observed by the Auger Collaboration, can be due only to protons as primary cosmic rays. The author's analysis of the data from the Auger Observatory showed that no correlation of the cosmic ray arrival directions with gamma-ray bursts is observed.

Judging the importance of the thesis for its scientific field, one must say that Mgr. Radomír Šmída's dissertation constitutes a large individual contribution to the collective effort of the Pierre Auger Collaboration. His analyses of hardware performance proved to be tremendously important for the success of the Observatory, and are being used in the Observatory operations. One should note that a prompt implementation of a graduate student's results into procedures of a large collaboration is clearly the young researcher's great scientific success. Mgr. R. Šmída is fully a co-author of the success of the Pierre Auger Observatory. The studies of cosmic ray propagation presented in this thesis will undoubtedly be very useful for subsequent analyses of experimental data on arrival directions of ultra-high energy cosmic rays.

The reviewer's duties require me to note also that regrettably, the dissertation is not free from flaws. It is written in a rather good English, however the use of English articles is far from being correct. Some fragments of the text are unclear, like Section 9.8. A number of awkward or imprecise statements can be found in the text, like "…the reasons why variable visibility of fluorescence telescopes must be controlled" (page 94, beginning of Section 8.7), or "…neutrinos or photons, born within a region of GRB can survive a long path from GRB situated at cosmological distance and arrive undeflected by the EGMF at the Earth atmosphere with an observable time difference ΔT ahead or behind corresponding γ-rays" (2nd paragraph on page 71). The captions of Figures 9.2-9.4 and 10.1 are incomplete: no information is given on the orientation of the camera pixels, i.e. which side is the top and which is the bottom of the camera or of the field of view. Moreover, the rotation of the image of Los Morados camera 6 shown in Figs. 9.2 and 9.3 adds to the confusion. Further, the first statement of Section 10.2 says "The brightness of night sky … increases with the zenith angle", while Figures 10.2 and 10.3 show that the opposite is true. The clarity of the dissertation would benefit a lot from short Chapter summaries, especially Chapter 6 and consecutive ones.

It should be stressed that the merits of the dissertation far outweigh its editorial deficiencies mentioned above. It is a pleasure to conclude that Mgr. Radomír Šmída's thesis meets all requirements for doctoral dissertations and proves its author's ability for creative scientific work.

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