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Plasma structuring and irregularities in the polar ionosphere

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Ionospheric plasmas are often subject to instabilities and turbulence, which consequently lead to plasma structuring and irregularities at various scales. Being the atmospheric layer that is directly connected to space, the ionosphere plays an important role in the energy transfer into the neutral atmosphere. Thus, studies of ionospheric plasmas can shed light on these fundamental problems in plasma physics but also help understanding the whole atmosphere system.

Processes that lead to structuring in ionospheric plasmas are often controlled by the geomagnetic activity. At high geomagnetic latitudes, plasma irregularities can be due to a multitude of phenomena that give rise to plasma structuring, for example the auroral particle precipitation or patches of enhanced plasma density being transported over the polar cap. Plasma irregularities at certain scales can influence the propagation of radio signals, and hence degrade communication or positioning with the Global Navigation Satellite Systems (GNSS), such as GPS or Galileo [1]. Thus, their understanding is an important aspect for developing space weather models and building the capability of predicting and mitigating severe space weather effects.

In this talk, I will present the current state of knowledge on the instability mechanisms leading to plasma irregularities in the ionosphere, as well as recent case and statistical studies focusing on a comprehensive understanding of plasma irregularities formation by combined ground-based observations and the in-situ and remote studies by sounding rockets and satellites. I will focus on the structuring related to different regions of the auroral oval and within the polar cap, and also discuss them in the interhemispheric context. The results from recent climatological studies of the global occurrence of irregularities and plasma variability based on the satellite data will be also presented in the context of the space weather effects observed with the ground-based instruments [2,3]. Finally, I will present ongoing initiatives which aim to develop models and forecasting services for the space weather effects in the polar regions, their status, challenges, and prospects.

References

[1] P. M. Kintner, et al., Space Weather, 5, S09003 (2007), doi:10.1029/2006SW000260.

[2] Y. Jin et. al., Journal of Geophysical Research: Space Physics, 124, e2020JA028103 (2020), https://doi.org/10.1029/2020JA028103

[3] D., Kotova et al., Advances in Space Research (2022), https://doi.org/10.1016/j.asr.2022.11.042.