

Posudek doktorské disertační práce

předložené na Matematicko-fyzikální fakultě
Univerzity Karlovy v Praze

posudek vedoucího posudek oponenta

Autor: Miroslav Hanzelka
Název práce: Nonlinear processes in space plasmas and their effects on the generation and propagation of electromagnetic waves
Studijní program a obor: Physics – Theoretical Physics, Astronomy and Astrophysics
Rok odevzdání: 2022

Jméno a tituly vedoucího/opponenta: Prof. RNDr. Ondřej Santolík, Dr.
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Odborná úroveň práce:

velmi dobrá vynikající průměrná podprůměrná nevyhovující

Věcné chyby:

téměř žádné vzhledem k rozsahu přiměřený počet méně podstatné četné závažné

Výsledky:

originální původní i převzaté netriviální kompilace citované z literatury opsané

Rozsah práce:

veliký standardní dostatečný nedostatečný

Grafická, jazyková a formální úroveň:

vynikající velmi dobrá průměrná podprůměrná nevyhovující

Tiskové chyby:

téměř žádné vzhledem k rozsahu a tématu přiměřený počet četné

Celková úroveň práce:

vynikající velmi dobrá průměrná podprůměrná nevyhovující

Slovní vyjádření, komentáře a připomínky vedoucího/opponenta:

The PhD thesis of Miroslav Hanzelka is based on results of his work on chorus. Electromagnetic emissions of chorus are nonlinear whistler-mode waves that occur naturally in the Earth's magnetosphere. According to observational evidence and theoretical investigations, the chorus wave elements are known to be formed by nonlinear interactions with anisotropic electrons around

the magnetic equator and to propagate bidirectionally to higher latitudes, from where they can also propagate down to the ground. These emissions have been recognized as an important driver of energetic electron fluxes in the outer radiation belt. They are responsible for local acceleration of electrons to relativistic energies. Chorus thus not only plays an important role in complex processes of the energy transfer between different electron populations but also constitutes an important element of radiation risks to space infrastructure. These waves can also cause precipitation of relativistic electrons from the radiation belts to the atmosphere.

In the frame of his thesis work, M. Hanzelka contributed to this very active field of research as the leading author of several publications in respected journals. A raytracing simulation study with density irregularities (Hanzelka and Santolík, 2019) explained the observational fact that chorus waves are approximately following the magnetic field lines. Observations of the Cluster and Van Allen Probes spacecraft missions revealed a fine structure of chorus emissions with short wave subpackets within each element, simulated by Hanzelka et al. (2020). The presence of subpackets modifies the effectivity of electron acceleration, supporting thus the need for a better understanding of the fine structure of chorus. Several theories have been proposed to explain the formation of chorus emissions. The initial growth stage is well described by the linear growth theory. In the second stage, whistler-mode waves start entrapping increasing numbers of resonant electrons, forming a phase space hole and disturbing thus the gyrotropy of the electron distribution (Hanzelka et al. 2021), which causes the formation of resonant currents. The resonant current modifies the dispersion properties of the wave and results in an enhanced, nonlinear amplitude growth, and in a drifting wave frequency.

In my opinion, the quality of thesis work of M. Hanzelka is outstanding. He is one of the best PhD students I have ever worked with. In the past, he led a student organization FYKOS, preparing physics exercises and activities for high school students interested in science. He wrote and led student research grants of the Charles University, providing additional research funding for physics students. He currently continues to lead one of these grants. He also wrote and led an application for a travel grant which provided him with additional funding for his stay at the Kyoto University in Japan. He now leads, for example, the Journal Club of the international VERSIM (URSI/IAGA) group, organizing online discussions with authors of recent papers.

He authored or co-authored 9 papers in top journals and, as I was involved in all of them, I can confirm that M. Hanzelka either led these papers or very actively contributed to them. He also repetitively won student paper competitions at international meetings, demonstrating the top-level quality of his work, his perfect knowledge of the subjects of his research, and his ability to answer tough questions. His PhD thesis contains material for other papers on which M. Hanzelka already started to work.

His PhD thesis, although it is written in a slightly unusual extensive way, is well readable and full of original ideas. I therefore recommend considering his thesis work as the PhD dissertation.

Práci

doporučuji

nedoporučuji

uznat jako doktorskou disertační práci.

Místo, datum a podpis vedoucího/opponenta:

Praha, 23.5.2022

