Ionospheric physics in the solar system, 10 credits

Goal & Content:

This graduate-level course gives a general treatment of the formation of ionospheres and how they electro-dynamically interact with the surrounding magnetospheres and solar wind. The purpose is to give an "overview map" of the basic space physics processes at work in our planetary system, with examples from several planets/moons/rings. The course is Face-to-Face in lecture rooms.

The course treats the following subjects:
Plenty of exercises will be taken from various planetary objects throughout the course.

Neutral atmospheres, introduction to exospheres, EUV and particle impact ionization, formation of ionospheres, some chemical kinetics, transport equations, basic fluid equations for neutral and charged gases, ambipolar diffusion, hydrostatic equilibrium. Chemical versus transport control, Thermal state of ionospheres.

Collision processes, ionospheric electrodynamics, atmospheric dynamos, MHD, Alfvén waves, instabilities & waves in ionospheres, application to radio waves, sounders: acoustic and gravity waves, hydro-dynamic instability, examples fluid Farley-Buneman and Rayleigh-Taylor.

Ionospheric conductivity, ionosphere & magnetosphere current systems, current closure and electro-jets, cowling channels, auroral electrodynamics, Solar Quiet currents, M-I coupling, Dungey cycle, Vasyliunas cycles for rapid rotators, Induction, Induced magnetospheres (Comets, Mars, Titan, Triton), Triton variable induction.

Dust-plasma interaction, Aerosol formation, Earth's D-region ionosphere, Titan's, Saturn's, Mars' dusty ionospheres, Enceladus & Europa plumes. Enceladus, Europa and Io torus formation. Dusty disks (e.g., E-ring). Exo-(iono)spheres around Mercury, the Moon and icy moons. (Icy) moon-magnetosphere interactions.

Comet interactions. [Guest lecture by A. I. Eriksson]
Ionospheric escape & polar wind. Exospheric escape. [Guest lecture by M. André]

Each section will be richly exemplified by observational information mainly from spacecraft near planetary objects within our solar system. The theory treatment applies equally well to ionised systems of astronomical interests, e.g. ionization near planet forming regions, molecular clouds, charged dust regions etc.

Literature:
Much of the course basics can be found in the book:

Ionospheres, physics, plasma physics, and chemistry, by R. W. Schunk and A. F. Nagy, Cambridge University press, 2009, ISBN 978-0-521-87706-0 Hardback. There are on-line versions!

The reading will also be based on research publications.

Prerequisites:
Master of Science in physics or equivalent is needed.

Examination:
Examination will be based on lecture attendance and can include presentations of selected subject-sections, numerical ionospheric calculations in groups, as well as home exercises.

Teachers:
Jan-Erik Wahlund, David Andrews, Stephan Buchert, Michiko Morooka.
Invited scientists may give additional seminars in related subjects when available.

Time & Place:
January - June 2022.
One lecture a week.
Start January 10, 2022.

Date	Day	Time	Place	Teacher (prelim)
10/1	Monday	10-12	12167	JWE
18/1	Tuesday	10-12	12167	JWE
25/1	Tuesday	08-10	11167	JWE
31/1	Monday	08-10	11167	JWE
7/2	Monday	08-10	11167	JWE
14/2	Monday	08-10	11167	JWE
22/2	Tuesday	10-12	12167	SB
1/3	Tuesday	13-15	12167	SB
9/3	Wednesday	10-12	11167	SB
16/3	Wednesday	10-12	11167	SB
22/3	Tuesday	10-12	90106	SB
29/3	Tuesday	10-12	11167	DA
5/4	Tuesday	10-12	11167	DA
12/4	Tuesday	10-12	11167	DA
19/4	Tuesday	10-12	11167	DA
26/4	Tuesday	10-12	11167	DA
3/5	Tuesday	10-12	11167	MM
10/5	Tuesday	10-12	11167	MM
17/5	Tuesday	10-12	11167	MM
24/5	Tuesday	10-12	11167	MM
31/5	Tuesday	10-12	11167	MM
7/6	Tuesday	10-12	11167	extra
14/6	Tuesday	10-12	11167	extra

If you are interested to participate, please notify Jan-Erik Wahlund (jwe@irfu.se) as soon as possible.