EgSA
وكالة الفضاء المصرية
Egyptian Space Agency

SPNEx
Space Plasma Nanosatellite Experiment Mission

How to monitor Space Plasma with Nanosatellites challenges and opportunities

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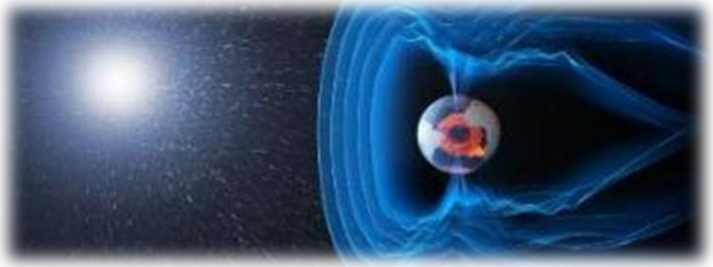
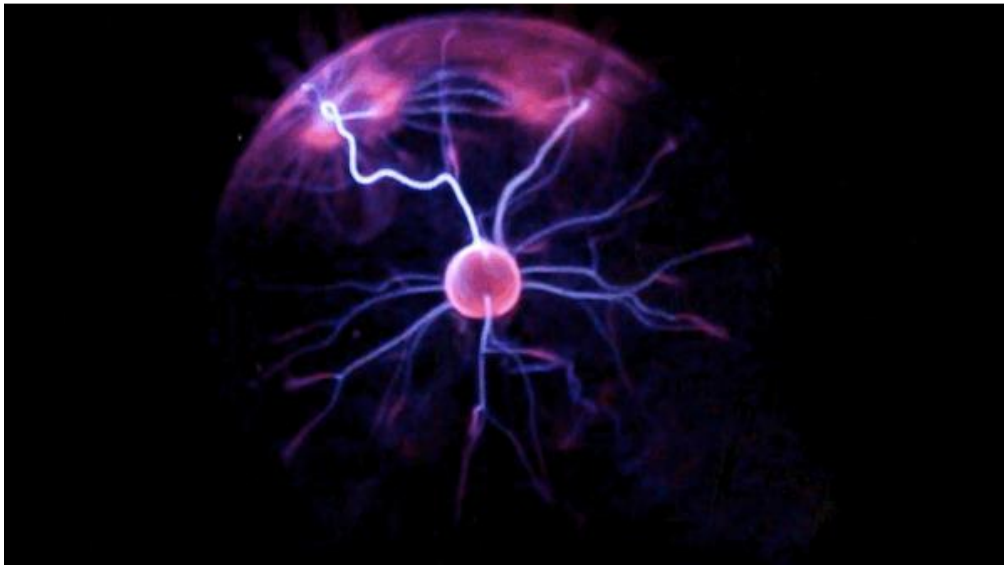
Agenda

- What is plasma?
- Why measuring space plasma in Ionosphere is important?
- About Space plasma Nanosatellite experiment- SPNEx.
- Scientific instruments.



what is plasma?

- A plasma is a **gas** that is **so hot** that some or all its atoms are split into electrons and ions, which move **independently** of each other.

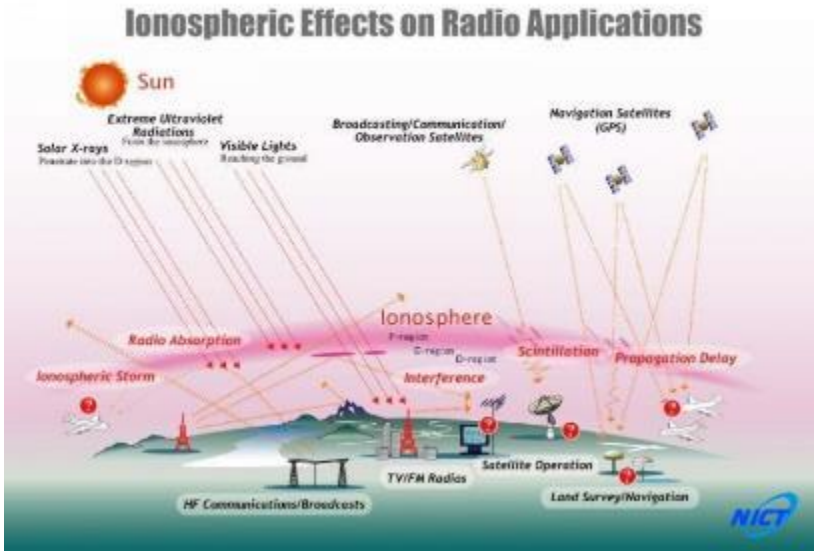


SPNEx
Space Plasma Nanosatellite Experiment Mission

Why measuring space plasma in Ionosphere is important?

- During space **weather events** there is a high flux of charged particles impacting the **upper atmosphere**.
- This can change the conditions in the **ionosphere** and interfere with radio and **satellite communications**.

- These increased **particle fluxes** are strongest at the poles so can also result in **diversion of flights**.
- The interaction between the solar wind and the Earth's magnetosphere can make the Earth's magnetosphere can make the Earth's magnetic field oscillate.
- Oscillating magnetic fields can generate electric currents, which in the case of Earth's magnetic field can then flow in **power grids**.



This graphic shows some of the effects that the ionosphere has on communications. Image: National Institute of Information and Communications Technology

Why measuring space plasma in Ionosphere is important?

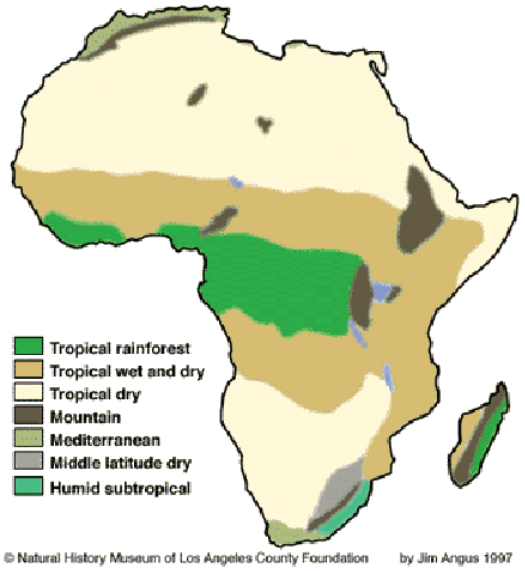
- **Plasma bubbles**: a disturbance at electric field / ionosphere which degrades/ scatters radio waves (GPS signal and navigation systems)
- North Africa usually has navigation systems disturbance in some times due to ionospheric disturbance.

We are trying to build/ improve the model of ionospheric disturbance effect on navigation system over north Africa.

Why measuring space plasma in Ionosphere is important?

Troposphere-ionosphere interaction:

- We try to investigate the relation between the climate change effects and the change occurs at ionosphere.
- Africa has the biggest effect due to climate change, but never been affecting factor in climate change.



Aim of the project

To build a 6U satellite with sensors that can enable:

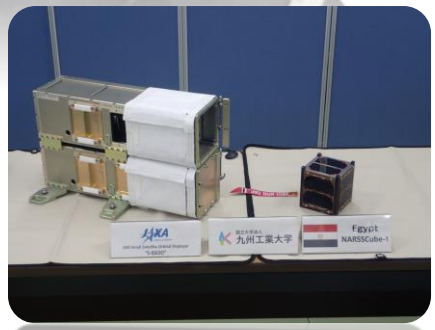
- To take measurement of plasma & electric and magnetic fields.
  - The measurements will help building an accurate model for effect of ionospheric disturbance on flight communication over Egypt.
- To link the ionospheric disturbance to the Atmospheric events;
  - this can serve as a climate model for Egyptian territory- Climate change effects on Egypt.

Project inputs

1. Outcomes of project- Space qualified- ISO/DIS 19683 camera computer system STDF (2013-2015)
2. Outcomes of project – space qualified integrated imaging system STDF (2016-2018)
3. Outcomes of TEDDSAT project 2017-2020: NARSSCube 1&2.

Credit to JAXA 2019
NARSSCube-1 Deployment from Kibo module

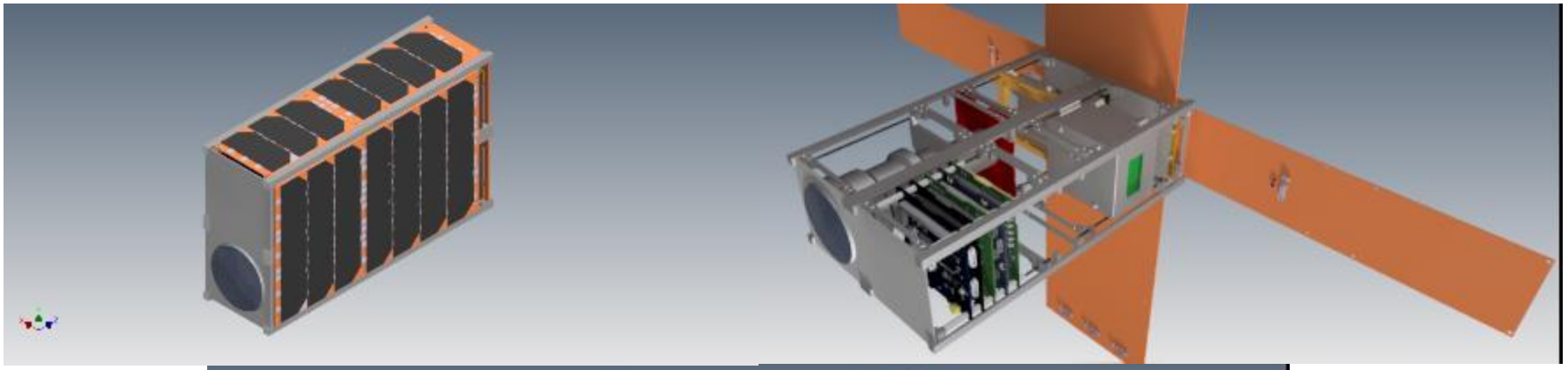
NARSSCube- 1
NARSSCube-2
Kyutech 2019

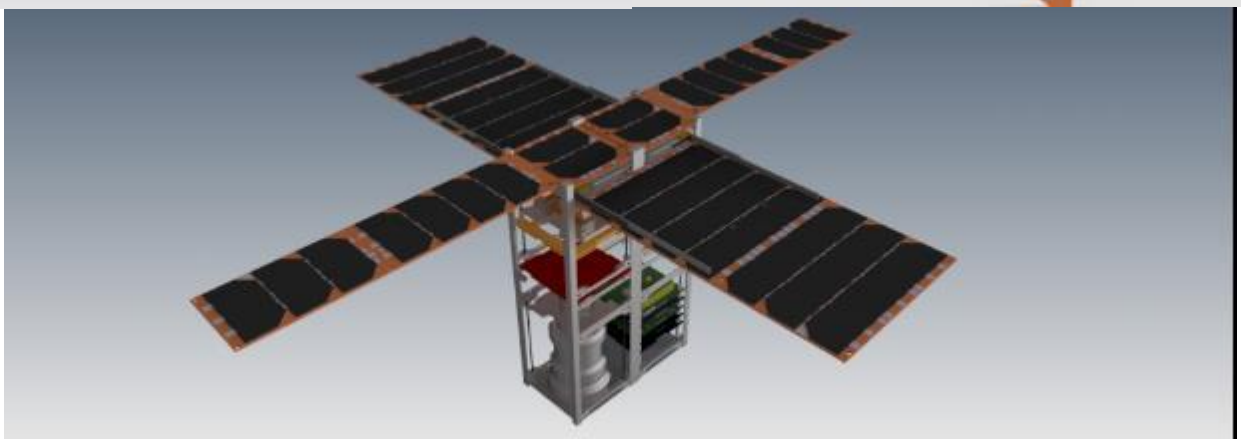


Credit to JAXA 2019

SPNEx
Space Plasma Nanosatellite Experiment Mission

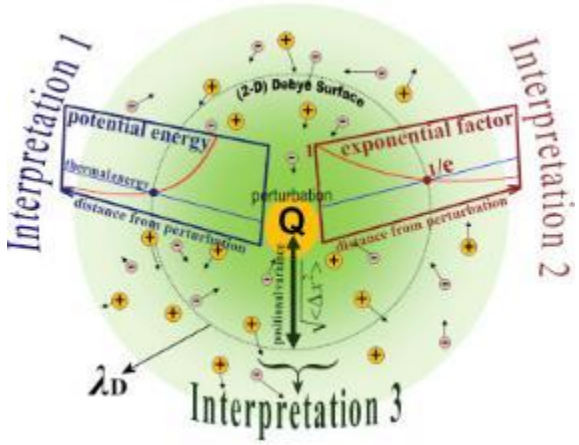
Satellite Preliminary Configuration





Measuring the plasma
Scientific Instrumentations

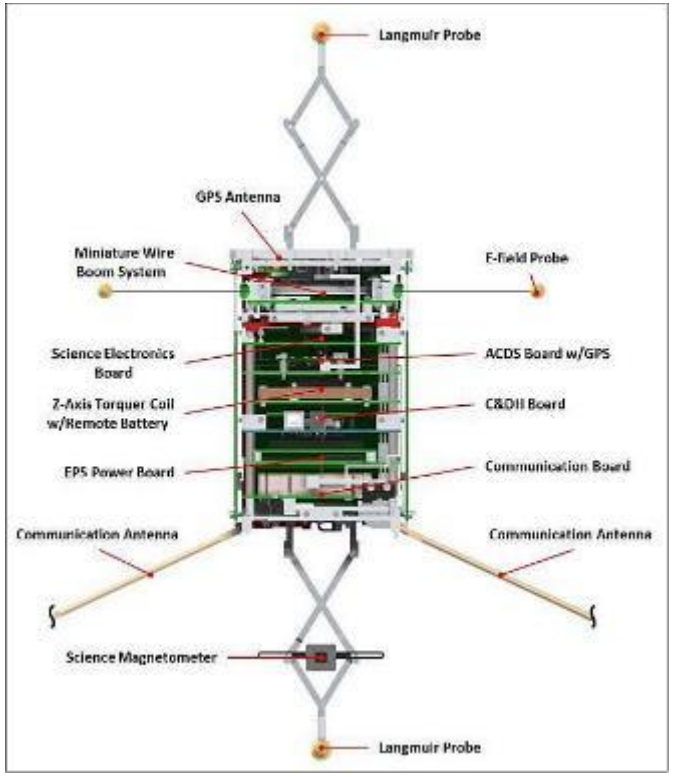
1. **Langmuir Probe:** The Langmuir probe is provided to measure plasma density. The measurements are based on the current-voltage (I-V) response characteristics of a conductor immersed in plasma at a Debye length or greater from surrounding structures.



https://www.sciencedirect.com/topics/earth-and-planetary-sciences/debye-length

Scientific Instrumentations

1. **EFP (Electric Field Probe):** The EFP, is provided to measure only one component of both DC and AC electric fields for identifying disturbed regions of the ionosphere. It is an implementation of the double-probe class of in-situ electric field instruments that has been used for decades to observe electric fields in the space environment.
2. **Magnetometer:** The magnetometer system will provide high-resolution measurements of the ambient magnetic field with sufficient sensitivity to potentially, observe perturbations due to pressure gradients, diamagnetic cavities.
3. **High energetic particle silicon detector.**



https://earth.esa.int/web/eoportal/satellite-missions/content/-/article/dice

Project outcomes

- 6U in-orbit satellite: constellation element
- Ionosphere plasma measurement data: AI based data processing/ big data
- Contribute to the COSPAR initiative “Task Group on Establishing a Constellation of Small Satellites (TGCSS)”

https://cosparhq.cnes.fr/scientific-structure/task-group-on-establishing-a-constellation-of-small-satellites-tgcss/

https://www.spacetechasia.com/chinas-leo-satcom-constellation-to-be-operational-by-2022-1st-satellite-to-launch-soon/

COSPAR: Task Group on Establishing a Constellation of Small Satellites (TGCSS)

Expressions of Interest

Following the announcement of the launch of the TGCSS initiative, COSPAR has received several Expressions of Interest from its national member institutions and international scientific unions.

1. International Union of Biological Science (IUBS)
2. UK Space Agency (UKSA)
3. Chinese National Committee for COSPAR (CNCOSPAR) and National Space Science Center (NSSC)
4. Egypt's Academy of Scientific Research and Technology (ASRT) and National Committee for Astronomy and Space Sciences (NCASS)
5. Czech Space Office (CSO)
6. Korea's MIST and Space Weather Center (KSWC)
7. Russia's Lomonosov Moscow State University
8. Spain's Instituto de Astrofísica de Andalucía (IAA-CSIC), Instituto de Microelectrónica de Sevilla (IMSE-CNM-CSIC), and Aerospace Electronics Group (GranaSAT)
9. Taiwan National SPace Organization (NSPO)
10. Israel's Ariel University, Ben Gurion University, Tel Aviv University, and one industrial company (NSLcomm)
11. India

https://cosparhq.cnes.fr/scientific-structure/task-group-on-establishing-a-constellation-of-small-satellites-tgcss/

Thank you