

#### Small Satellite Formation Flying System based on Space Exploration & Imaging Observation Technology

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#### 1.1 The requirement of the imaging observation



**Flood disaster** 



Landslides



#### Hurricane monitoring



Ravages of a drought monitoring



Investigation of forest resources



surveying and mapping



The requirement of observation resolution and accuracy is higher.

#### **1.2 The development of imaging observation**



#### **1.3 The current situation of imaging observation**



technology development is swift and violent, the resolution is better than 0.5 m,

#### 1.4 The mode of imaging observation



The technology of distributed satellites formation system is the trend of future

development

### 1.5 The imaging observation using three satellites formation

- The imaging observation using three distributed satellites
- Ascending the observing of low obit filed of view.
- Stereo imaging
- maneuvering observation
- Satellites constellation
- Density of function is higher
- $\succ$  Low cost
- Short development cycle
- Ease of formation and



**Furthermore**, three satellites formation system can applied to the near earth

space environment detection



Imaging observation used Three small satellites Distributed Formation



The importance of the space environment exploration



To date, about 40% satellite failures from more than 6,000 caused by the abnormity of the space environment

In particular , the late of the sun broke out for peak years , such as 2012 , will have a dramatic impact on near-Earth space environment

Affect the signal relay,

**Important scientific** 



electromagnetic transmission

significance

**1.7 The status quo of distributed environment exploration** 

The multi-plans of distributed exploration of space environment has been implemented

SOLAR HELIOSPHERIC International **Living With** MAGNETOSPHERIC a Star (ILWS) IONOSPHERIC Solar Max Solar Max Solar Max Year → 92 98 00 02 06 08 10 12 14 16



**Distributed satellite** is an important means of probing the space

environment







The research progress







#### 2. The research progress

2.1 Magnetic Suspended(MS) inertial actuators technology For the requirements of the next-generation satellite's high-precision stability and rapid movement performance, successfully, Beihang developed MSFW and MSCMG which will be used for our future high-resolution Earth



## 2、The research progress

#### 2.2 "Three satellite formation for space environment exploration" key project

"Eleventh Five-Year" period, the Beihang University jointing with DFH Satellite
 Ltd., Chinese Academy of Sciences Space Center and Tsinghua University
 the "Three satellite formation exploration space environment" key project



#### 2. Research process

#### 2.2 "Three satellite formation for space environment exploration"

#### Three innovation science exploration tasks

**(1)** research of accuracy detection/exploration for the shadow side of near-earth space environment current system

**(2)** research of near-earth plasma environment in small scale structure and motion law

③ the increase and decrease of high energy particle in radiation belt both in time and in space evolvement process

**Realize the Identical orbit, in-situ, multi points and multi-scale exploration** 



Magnetometer



Low energy particle detector



High energy particle detector



- 2.2 "Three satellite formation for space environment exploration"
  - key technologies
  - Integrated technology of the scientific detection payload
  - High performance attitude and orbit control technology based on micro-instrument/device
  - Formation configuration and cooperative control for micro-nano satellite
  - > The terrestrial test of distribution for the satellite formation configuration and measurement



#### 2. Research process

#### Key point 1: Integrated technology of the scientific detection payload







Three-axis stabilized micronano satellite

Spin-stabilized micro-nano satellite

on-board integrated electronic systems

- the design based on the integration of payload and structure, build up the configuration and layout of the three-axis stabilized and spin-stabilized micro-nano satellites
- with the restriction of the mass, power and volume of the satellite, an on-board integrated electronic framework is designed based on the attitude and orbit control
   / energy / communication / payload / satellite service modules



#### 2. Research process

Key point 2: High performance attitude and orbit control technology based on micro-instrument/device



Star tracker/ FOG/ Magnetometer/ Sun sensor

high-performance of three-axis satellite Integrated attitude determination system



MEMS gyros/ 'Z' style slit sun sensor Micro-Magnetometer

high-performance spin satellite Integrated attitude determination system Highly reliable and high-precision measurement technology based on integrated miniature device



Small flywheelbased highstability control



Small propulsion system (Propellant: propane)

Small flywheel-based high-stability control Small propulsion system with propane for the attitude and orbit control





Key point 4: The terrestrial test of distribution for the satellite formation configuration and measurement

- Achieving the three innovative scientific exploration missions of nearearth space environment using distributed satellite formation monitoring technology;
- Completing the whole process of scientific exploration tasks real-time simulation based on terrestrial demonstration system;
- Finishing there satellites coordination control and terrestrial demonstration based on distributed real-time simulation technology .



















# **"3 +2" Small-satellite Project**

Developing ''3 +2'' micro-satellite to carry out experimental verification of new technologies and the near-earth space environment exploration.





#### **Task 1 ---- Experimental Verification of New Technologies**

**1** Agile maneuver control technology based on novel actuator

**(2)** Autonomous celestial navigation using new type of sensor







2.1 Task 1 ----- Experimental Verification of New Technologies

New Technologies 2: Autonomous celestial navigation technology

#### Attitude sensor:

□ Micro CMOS Star Sensor + Micro CMOS Earth Sensor

#### **Autonomous celestial navigation method:**

□ Directly sensing horizon method + Indirectly sensing horizon method



#### 2.1 project mission—1) new technological experiment

New technological experiment task 3: validation of satellite formation





#### 2、 Overall mission analysis and technology requirement

2.1 project mission—2) space environment exploration

#### **Three innovation tasks**

(1) research of accuracy detection/exploration for the shadow side of near-earth spenvironment current system

**2** research of near-earth plasma environment in small scale structure and motion lav

(3) the increase and decrease of high energy particle in radiation belt both in time and in space evolvement process

#### **Three extended tasks**

**(4)** evolvement process and forms of aurora when auroral storm and auroral electrojet occurs

**(5)** coupling effect between magnetosphere and ionosphere

**ionosphere disturbance** induced by activity of magnetosphere



2.1 project mission—2) space environment exploration Scientific task 4: research on evolvement process and forms of aurora when auroral storm and auroral electrojet occurs



- payload: aurora sensor
- ultravilolet aurora micro imaging detector A
   Low energy particle micro sensor B1, B2

  Formation exploration measurement
  - Identical orbit, in-situ, multi points, multiple parameters, small scale,
    - Research on evolvement process of auroral forms



### 2.1 project mission—2) space environment exploration Scientific task 5: research on coupling effect between magnetosphere and ionosphere



• Payload: network distributed sensor for coupling effect exploration between

#### magnetosphere and ionosphere



• Identical orbit, in-situ, multi points, multiple parameters, small

scale, Research on transport phenomena of energy and mass between magnetosphere and ionosphere

#### 2.1 project mission—2) space environment exploration

Scientific task 6: research on ionosphere disturbance induced by activity of magnetosphere



payload: network distributed sensor for space plasma



Identical orbit、in-situ、multi points、multiple parameters、 small scale, Research on propagation of disturbance

















- **D** Space mission analysis
- Formation flying system design
- Space probe payload

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## Thank you

