Annex 1

Technical Specifications of Scientific Payloads for Asteroid Exploration Mission

No.	Payload	Exploration task	Main functions	Main technical specifications
1	Color camera with intermediate field of view	1) To image the global asteroid 2) To obtain parameters including shape, size, surface morphology, rotational period and orbit.	1) Be able to obtain the color image of the asteroid (a fainter target). 2) With self-adaption. focusing and dimming capabilities. 3) With stray light reduction measures; 4) With image compression capability; 5) Has the imaging capability when the solar altitude angle is greater than 10°; Better have imaging capability when the solar altitude angle is greater than 5° is preferable; 6) Has the on-orbit calibration capability.	Mass: ≤6kg Power consumption: ≤30W Band range: better than 0.45μm~0.76μm Color: multicolor Imaging mode: frame image Imaging range: better than 4m~∞ Pixel resolution: better than 1m at the orbital altitude of 10km Width: better than 4km×4km at the orbital altitude of 10km Quantization digit: ≥8bit Image signal-to-noise ratio: ≥40dB (target reflectivity: 0.2; solar altitude angle: 30°) MTF: ≥0.2 (under Nyquist frequency, full-field static transfer function) Data compression: no compression; compression ratio: 2:1/4:1/8:1 Albedo of detected target: 0.03~0.6
2	Thermal emission spectrometer	1) To obtain the spectral image of heat radiation on the asteroid surface, and explore the heat radiation features for the study of the Yarkovsky effect. 2) To obtain the spectral data of heat radiation for the study of mineral distribution on the asteroid surface.	1) Has the thermal IR imaging capability. 2) Has the data compression capability. 3) Has the on-orbit calibration capability.	Mass: ≤10kg Power consumption: ≤50W Spectral range: better than 5.0~50.0μm Spectral resolution: better than $10cm^{-1}$ (29nm@6μm) Spectrum sections: no less than 100 Signal-to-noise ratio: better than 320 (under 5.0~35.0μmband at 325K) Angular resolution of detection unit: better than 2mrad Pixel resolution: better than 10m at the orbital altitude of 5km Scanning width: better than 2km at the orbital altitude of 5km Point spectrum detection time: 2s~3s (for each detection point) Quantization digit: ≥10bit Data compression: no compression; compression ratio: ≥2:1 Albedo of detected target: 0.03~0.6

No.	Payload	Exploration task	Main functions	Main technical specifications
3	Visible and IR imaging spectrometer	1) To obtain high-resolution imaging spectral data from visible to IR spectrum on the asteroid surface; 2) To in-situ prospect the landing area on the asteroid, and obtain high-resolution spectral data from visible to NIR spectrum about the area of interest.	1) Both orbiting detection and in-situ detection requirements should take into account. Obtain the IR spectral image for the target. 2) Has the IR spectral detection capability for the shadow area through its own active light source. 3) Has the optional spectral detection capability. 4) Has the capability of imaging specific target. 5) Has the data compression capability. 6) Has the on-orbit calibration capability.	1) Mass: ⩽15kg 2) Power consumption: ⩽60W 3) Spectral imaging Spectral range: better than 0.45~4.50μm Spectrum sections: no less than 500 Spectral resolution: better than 8nm (0.5~1.0μm) better than 15nm (1.0~2.5μm) better than 25nm (2.5~4.5μm) Effective pixels: using the linear array push-broom imaging method no less than 1024×1 (0.5~1.0μm) no less than 320×1 (1.0~4.5μm) Pixel resolution: better than 0.5m at the orbital altitude of 5km Width: no less than 160m×0.5m at the orbital altitude of 5km Signal-to-noise ratio: ≥40dB (target reflectivity: 0.2; solar altitude angle: 30°) MTF: ≥0.2 (under Nyquist frequency, full-field static transfer function) Frame frequency: 0.2Hz at the orbital altitude of 5km; 0.1Hz at the orbital altitude of 10km; 0.05Hz at the orbital altitude of 20km Detection method: spectral imaging mode, spectral detection mode Albedo of the target to be detected: 0.03~0.6 4) Spectral detection by active lighting Spectral range: better than 0.5~2.4 μm Effective lighting distance: better than 0.5~1.5 m Irradiance at the target: under the condition of albedo of 0.3, the signal-to-noise ratio of 100, and 1.5m away from the light source, the spectral irradiance of the target lit surface is: no less than 95W/m²/μm@0.5μm, no less than 560W/m²/μm @ 1.0μm, and no less than 23W/m²/μm at 2.4μm. 5) Data quantization and processing Quantization digit: ≥10bit Data compression: no compression; compression ratio: ≥2:1 6) Two-dimensional pointing Target pointing range: pitch angle: ±25°; azimuth angle: ±25° Pointing accuracy: ≤0.3° Pointing angle resolution: better than 0.2°

No.	Payload	Exploration task	Main functions	Main technical specifications
4	Multispectral camera	1) To perform the multispectral imaging of the landing area on the asteroid for the study of morphology and material type on the asteroid surface. 2) To conduct specific spectrum detection for the landing area, offering context information for sample collection, and helping to determine the sample objects.	1) Be able to obtain the multispectral image from visible to NIR spectrum about the asteroid surface. 2) Carry active light source with the imaging capability for the shadow area. 3) With the two-dimensional pointing capability to obtain the reflected spectral data of a specified target point. 4) With the automatic and remote-control exposure regulation capability. 5) With the automatic and remote-control focusing adjustment capability. 6) With stray light reduction measures. 7) With the anti-dust interference capability; 8) With the on-orbit calibration capability.	1) Mass: ⩽3.5kg 2) Power consumption: ⩽20W 3) Spectral imaging Spectral range: better than 480nm~1000nm (under sunlight); better than 480nm~700nm (under active light) Field of view: no less than 16°×16° Effective pixels: no less than 2048×2048 Imaging range under sunlight: 0.5m~+∝ Signal-to-noise ratio: ≥40dB (target reflectivity: 0.2; solar altitude angle: 30°) MTF: ≥0.2 (under Nyquist frequency, full-field static transfer function) Albedo of detected target: 0.03~0.6 4) Active lighting Spectral range: better than 480nm~700nm Effective lighting distance: better than 0.5~5m Illuminance at the position of the target: no less than 10lux at 5m away from the light source 5) Two-dimensional pointing Target pointing range: horizontal angle: 360°; pitch angle: -30°~30° Pointing accuracy: ≤0.3° Pointing angle resolution: better than 0.2° 6) Data quantization and process Quantization digit: ≥10bit Data compression: no compression; compression ratio: 2:1/4:1/8:1
5	Detection radar	To obtain the radar echo data of asteroid surface and subsurface, and detect the asteroid subsurface structure.	1) With the capability to obtain the echo data of asteroid/Comet surface and subface. 2)With data compression capability.	Mass: ⩽15 kg Power consumption: ⩽ 50 W Center frequency: 150 MHz Bandwidth: 100 MHz Penetration depth: > 10 0m Height resolution: better than 2m (when the dielectric constant is 3) Transmitting power: 10 W Antenna type: symmetrical dipole Polarization: dual polarization Antenna length: ≤1.2 m

No.	Payload	Exploration task	Main functions	Main technical specifications
6	Magnetometer	1) To detect the magnetic field of the asteroid, and obtain potential magnetic field distribution data. 2) To detect the magnetic field of the main-belt Comet, and understand the remanence intensity and distribution of the main-belt Comet.	1) With the high-resolution vector measurement capability for the magnetic field of asteroid/Comet. 2) With data compression capability.	Mass: ⩽1.8 kg Power consumption: ⩽2.6 W Maximum measuring range: ±65000 nT Dynamic measurement range: 2000 nT Resolution: better than 0.01 nT Noise level: better than 0.01nT/√Hz Zero drift: better than 0.01nT/°C Sampling rate: 1 Hz, 10 Hz, 128 Hz
7	Charged and neutral particle analyzer	1) To measure the neutral gas composition and its isotopes and the cold plasma ions and their isotopes near the main comet, in combination of the measurement to the dust particle environment, so as to study the formation and evolution of the main-belt Comet's atmosphere and ionosphere, as well as the active driving force and mechanism of the main Comet; 2) Through measure the plasma environment of the main-belt Comet and the asteroid, in combination of the measurement of the spatial magnetic field, study the interaction between solar wind and the Comet and asteroid.	1) Be able to detect the ionization components of the Comet's atmosphere and ionosphere. 2) Be able to obtain the flux data of solar wind plasma (ion and electron), atmospheric sputtering and reflecting ions and solar wind "pickup" ions near the asteroid and the Comet.	1) Mass: ⩽7 kg 2) Power consumption: ⩽20 W 3) Ionization components of neutral atmosphere and ionosphere •Mass range: 1~150 amu •Mass resolution: better than 1amu (Mass range: 1~50 amu); better than 1.5amu (Mass range: 51~150 amu) •Dynamic range: 1×10^9 •Temporal resolution: 4s~256s (adjustable) 4) Ion •Energy range: 5eV~30keV •Energy resolution: better than 15% •Energy channels: no less than 64 •Mass number: 1~70amu •Ion resolution capacity: distinguishable from the H^+, He^{++}, He^+, O^{++}, O^+ group (N^+, O^+ and H_2O^+), O_2^+ group (N_2^+ and O_2^+), CO_2^+. •Field of view: 360° (azimuth angle) × 90° (pitch angle) •Angular resolution; better than 25° (azimuth angle) × 12° (pitch angle) •Temporal resolution: 4s~256s (adjustable) 5) Electron •Energy range: 5eV~10keV •Energy resolution: better than 15% •Energy channels: no less than 64 •Field of view: 360° (azimuth angle) × 90° (pitch angle) •Angular resolution; better than 25° (azimuth angle) × 12° (pitch angle) •Temporal resolution: 4s~256s (adjustable)

No.	Payload	Exploration task	Main functions	Main technical specifications
8	Dust analyzer	To detect the physical and dynamic characteristics and the distribution of the dust on the asteroid belt and main-belt Comet.	Be able to detect the mass, velocity, flux and cumulative mass of the dust particle on the Comet.	Mass: ⩽ 8kg Power consumption: ⩽ 10W Particle radius: 0.5 μm~500 μm Particle mass: 1×10^{-10}~ 4×10^{-1} g Velocity: 1m/s~500m/s Flux: 6×10^{-12} g/cm·s Cumulative mass: 1×10^{-9}~ 3×10^{-4} g/cm^2