

Paper Models of Spacecrafts for Education and Public Outreach *

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A series of paper models of spacecrafts for education and public outreach is being developed. The models are accurate because they are designed based on the drawings or photos of the original spacecrafts and because they reproduce some of the important characteristics of the spacecrafts. Moreover, most of the models have movable/detachable parts. Each set consists of four components - cover story, instructions, drawings, and background information. The cover story explains outline of the spacecraft and its technical merits. Drawings of parts fit in 2-3 sheets of A4 paper. Because of the large number of parts, the 1-2 pages written instructions are not friendly enough, and thus several photographs are used. Finally the background information explains specific topics related to the spacecraft, such as deployable space structures. With these models, learners may understand basic structures of spacecrafts as well as some of the key technologies related to the cutting-edge instruments.

Key Words: Education, Public Outreach, KAGUYA (SELENE)

1. Introduction

For public outreach, paper models are reasonable choice since they are cheap (often free) and easily customized. In comparison to other outreach materials such as pamphlets and fliers, paper models are substantially more *resistant*, and often reach *alive* visitors' home. There is a large population of those who love paper models. Once there, they attract peoples for hours. One can imagine that no one reads a pamphlet for hours at home, while there are many who work with paper models for hours until midnight.

When appropriately designed, paper models also become good teaching materials that do not limit the targets to specific science fairs. As a bi-product, completed exact models are often exhibited for serendipitous secondary influences while a children trick may not.

The present project emphasizes these aspects and aims to design a series of paper models that are useful to learn (or explain) structure of characteristic satellites, rockets, telescopes, tracking ground stations, and their key technologies.

2. Design Concept

The models were designed with the following policies in mind:

- (1) Accurate - The models are accurate in a sense that they reproduce not only the original appearances but also essential structures of the telescopes. To this end, the models were designed based on actual drawings or measurements. Also, some parts even invisible from outside were included when appropriate.
- (2) Interactive - Paper models are interactive teaching materials themselves. In addition, each model was

designed so that it remains interactive even after completion, namely each model is steerable and, when possible, parts-exchangeable.

- (3) Simple - As a natural tradeoff of (1) and (2), it was inevitable to assume that the models will not be made by unassisted kids. However, efforts were made to keep the models as simple as possible so that entire parts of each model fit in 2-3 pages of A4 paper and each model can be completed within reasonable amount of time by non-experts.

- (4) Free - For educational purposes, the materials should be freely distributed via internet. This requires that any of the figures and photographs used in the materials should clear copyright issues and that the format is to be PDF or equivalent.

3. Individual Models

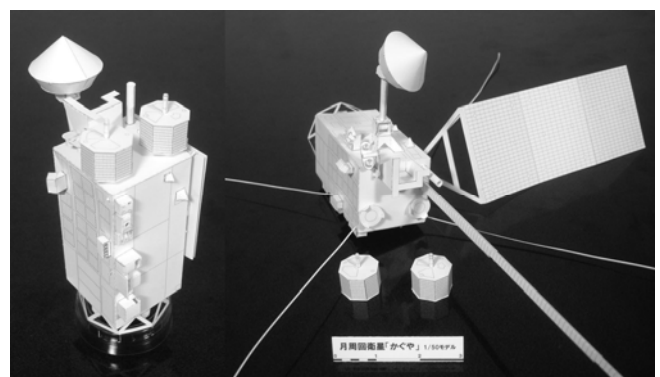


Fig. 1. Paper model of KAGUYA (SELENE)

Figure 1 shows a paper model of JAXA's lunar explorer, KAGUYA (SELENE), which was launched on September 14, 2007. This 1/50 scale model fits in a PET bottle when folded as it did in a nose fairing (left), and deploys (right).

This model reproduces basically all the actions the spacecraft did in space, with 11 movable/detachable parts: deployment and rotation of the solar paddle, deployment and azimuth/elevation steering of the high gain antenna, separation of OKINA and OUNA subsatellites, deployment of Lunar Radar Sounder (LRS) antennas, deployment of Lunar Magnetograph (LMAG) mast, and deployment and steering of Upper atmosphere and Plasma Imager (UPI).

Prototypes of ASTRO-G and AKEBONO are also under development.

These newly designed models compare earlier suite of paper models of ground-based telescopes (ALMA and its antenna transporter, ASTE, VERA, NRO 45 m Radio Telescope, Very Small Telescope-1, Nobeyama Radio Heliograph, IGP 32 m VLBI antenna, Subaru, OAO 188 cm telescope, and OAO 91 cm telescope), which are available via the ALMA-Japan homepage at <http://www.nro.nao.ac.jp/alma/>.

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With these models, learners may understand basic structures of spacecrafts as well as some of the key technologies related to the cutting-edge instruments. PDF files of these models are available online via the ISAS/JAXA homepage at <http://www.isas.jaxa.jp>.

4. Use Cases

Each of the models is useful as a teaching and public outreach material. Moreover, use of two or more models brings some synergy effects: For instance, by comparing the structures of the radio and infrared space telescopes, one may understand that the basic structures of the reflecting telescopes are all alike.

The models also helps us a lot in explaining how the spacecrafts will work in orbit.

5. Future Plans

Future plans include friendly-enough instructions, expansion of line-up, English translation, and die-cutting of parts sheets.

References

- 1) Sakamoto, S.: Paper Models of Spacecrafts for Education and Public Outreach, *Proceedings of Asian Pacific Regional IAU Meeting* (2005)