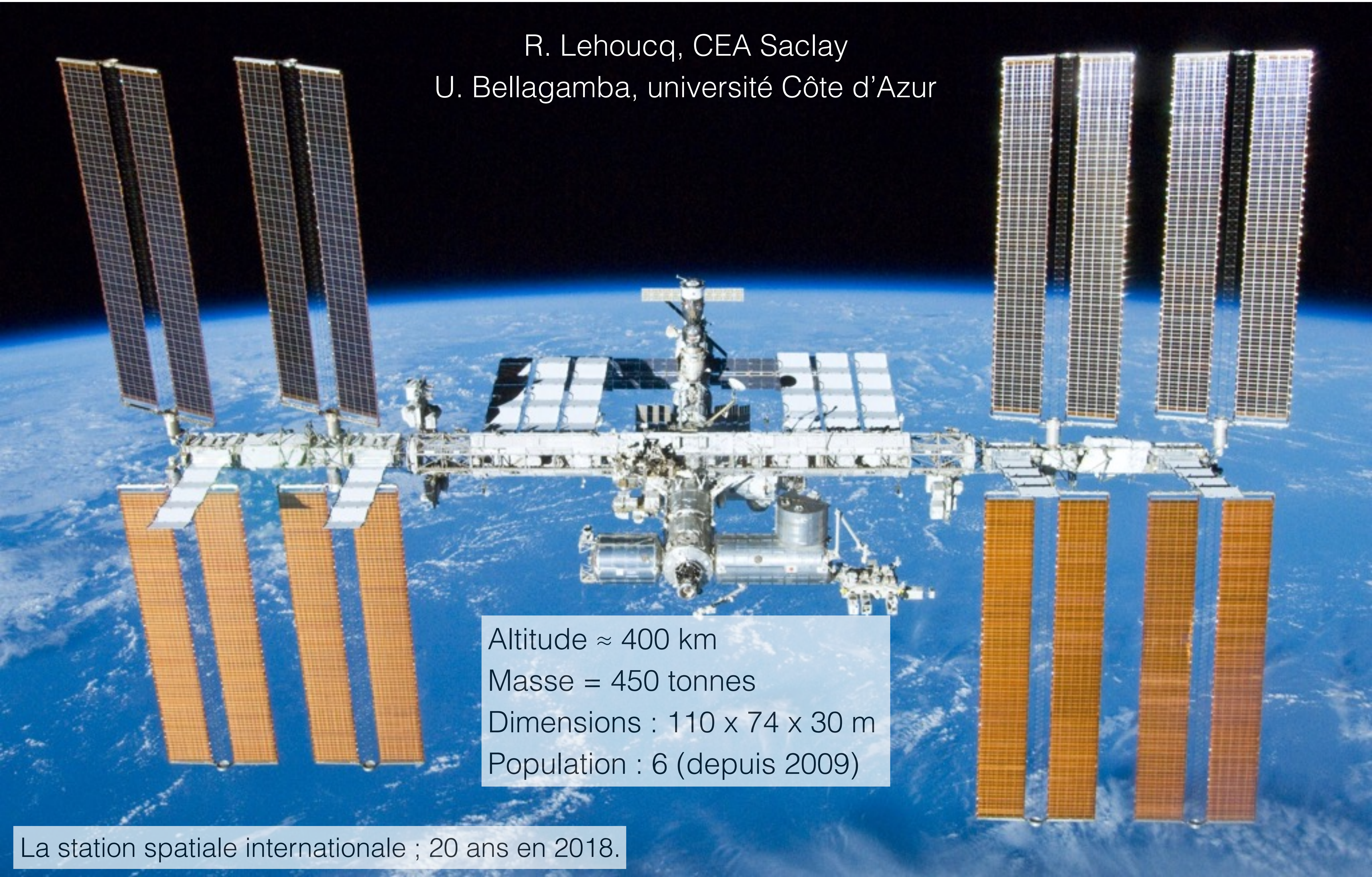
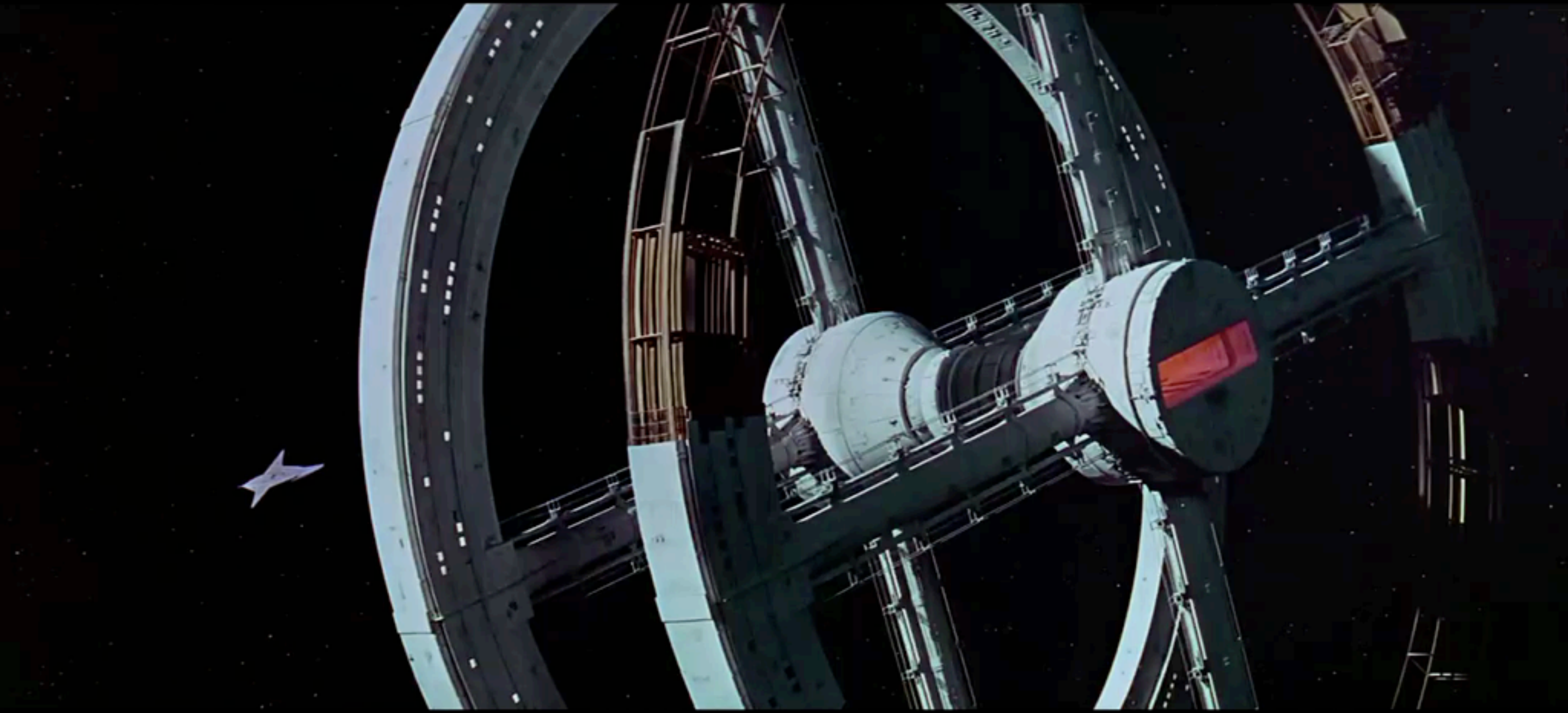
Les stations spatiales

R. Lehoucq, CEA Saclay
U. Bellagamba, université Côte d'Azur



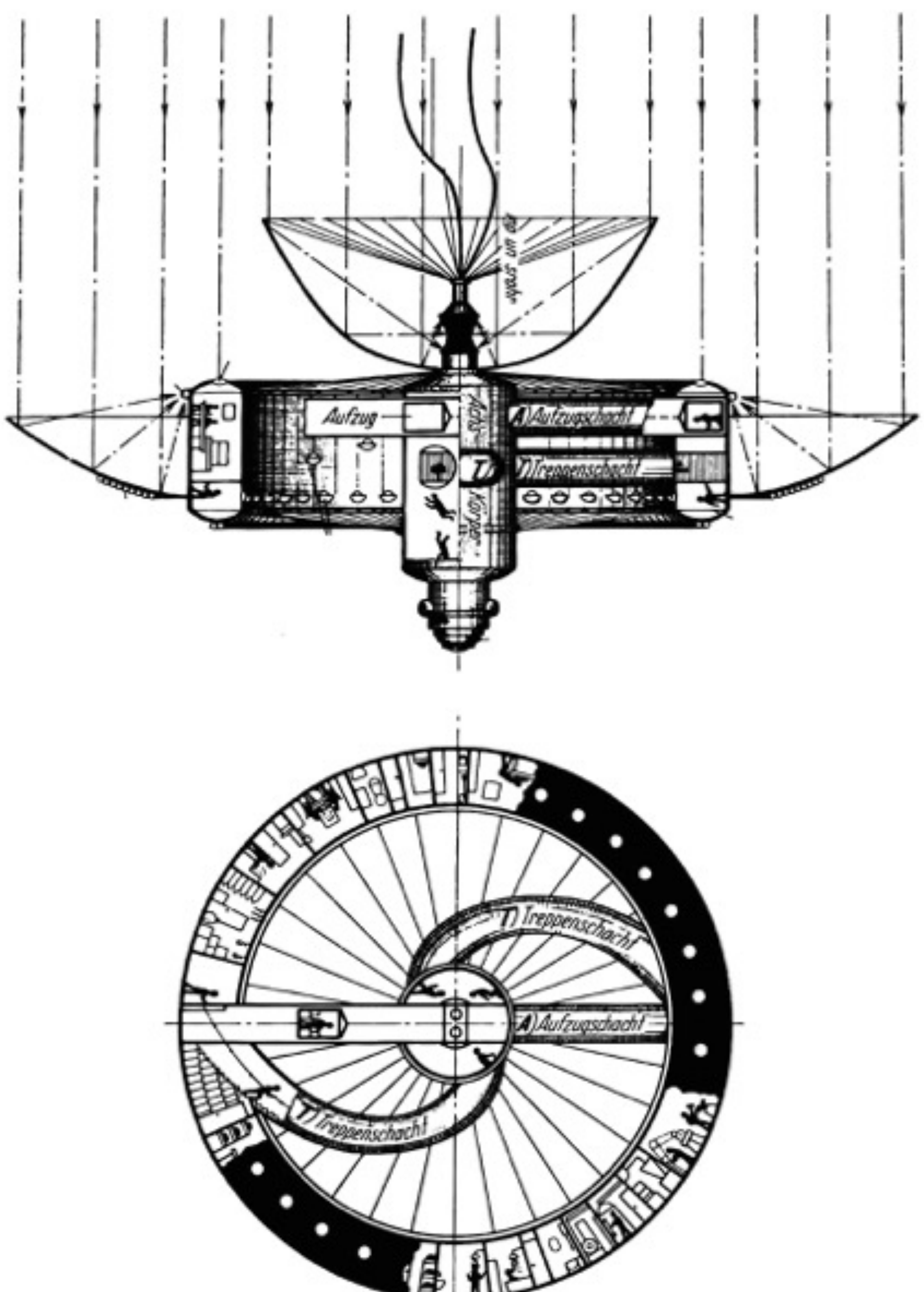
Altitude ≈ 400 km
Masse = 450 tonnes
Dimensions : 110 x 74 x 30 m
Population : 6 (depuis 2009)

La station spatiale internationale ; 20 ans en 2018.

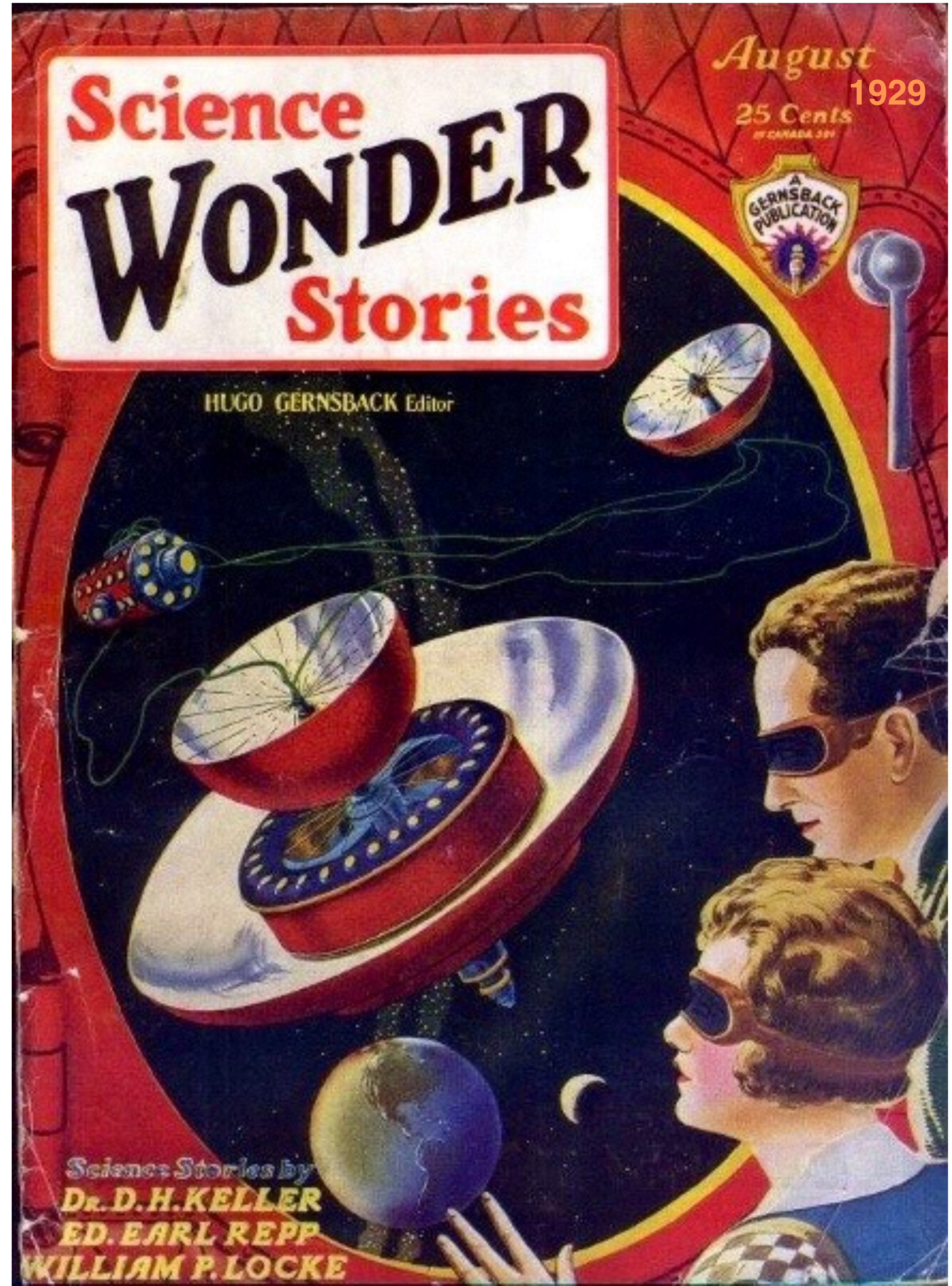


L’arrivée à la station orbitale ; *2001 l’Odyssée de l’espace* (Stanley Kubrick, 1968).

Les pionniers



La station géostationnaire d'Herman Potočnik (1928)



VOLUME 1
No. 10

AIR WONDER STORIES

APRIL
1930

The Future of Aviation Springs from the Imagination

Professor Hermann Oberth, perhaps the greatest authority on interplanetary space, points out many uses for such revolving "space stations," as he calls them. A better word, perhaps, would be "revolving space observatories."

STATIONS IN SPACE

By HUGO GERNSBACK

ONE of the common misconceptions of the average man, or the layman, about the science of space-flying, is that, in order to hover above the earth, it would be necessary to choose the exact point where the gravitational fields of the earth and moon balance (about 216,000 miles above the earth, and 22,000 miles from the moon). This is an erroneous idea, however; for it is possible to fly continually around the earth without the expenditure of any power in doing so. Once a space-flyer has been given a sufficient initial impulse, it can keep on going forever, comparatively close to the earth's surface, without danger of falling.

Impossible as this may seem, the statement is perfectly true. It will be necessary only to build a rocket ship and elevate it beyond the appreciable atmosphere of the earth—say a trifle over five hundred miles—then give it a sufficient impulse in a direction at right angles to the position of the earth. It will then continue to gravitate around the earth without falling; thus becoming a new satellite; and it will maintain its orbit permanently until it is disturbed by some external force. Of course, at such a distance, it is to be supposed that no atmospheric friction will be encountered to reduce the original speed—which must be in the order of five miles a second. This is rather low, as planetary velocities are considered. Once the space flyer has reached the critical speed, it will continue to revolve around the earth—in a period of less than two hours at this distance—exactly as the moon now revolves about us, and without the need of added propulsive force.

It might be asked: what useful purpose would be served by converting a space-flyer into a permanent, rapidly-revolving satellite of the earth in this manner?

Professor Hermann Oberth, perhaps the greatest authority on interplanetary space, points out many uses for such revolving "space stations," as he calls them. A better word, perhaps, would be "revolving space observatories."

In the first place, from such a height, it will be possible to make any amount of astronomical observations in free space without having to worry about clouds or the interference of the atmosphere. Marvellous photographs can thus be taken, not only of distant stars and planets, but of the earth's surface as well.

One important purpose, as Professor Oberth points out, is the invaluable aid that such an observatory can give to the science of meteorology, or weather prediction, as it is more popularly known.

If the observatory is equipped with radio, instantaneous communication can be had with the various meteorological stations scattered all over the earth and, if there are a number of such observatories circling around the earth (let us say four or eight), they can immediately notify any station on earth as to probable weather conditions. Movements of clouds; fog formations; icebergs, etc., can be immediately reported. If there had been such observatories years ago, one could have prevented the sinking of the *Titanic*, because the ship could have been notified by the circling observatory of the dangers in its path. Such dangers can be spotted much more quickly from above than from the surface of the sea, particularly when there is a thin layer of fog intervening on the sea.

Most of our bad weather is created in the polar regions. It is practically impossible today to know what is brewing in these regions, because they are too extensive to cover with fixed weather stations. But circling observatories, such as Oberth proposes, would notice immediately the breaking up of ice, formations of new ice, pack ice, etc.

Equipped with powerful telescopes, at a distance of 500 miles above the surface of the earth, it would be a simple matter for the scientists in the observatory to spot even smaller objects, such as airplanes. The circling observatory, for instance, would have been in position to watch the tragic flight of Nungesser and Coli across the Atlantic in 1927, and could have given, instantaneously, a report of the exact spot where the plane came down. Expeditions into deserts and into polar regions, as well as into unexplored regions at any place on earth, could thus be easily watched and reports of their progress given instantly.

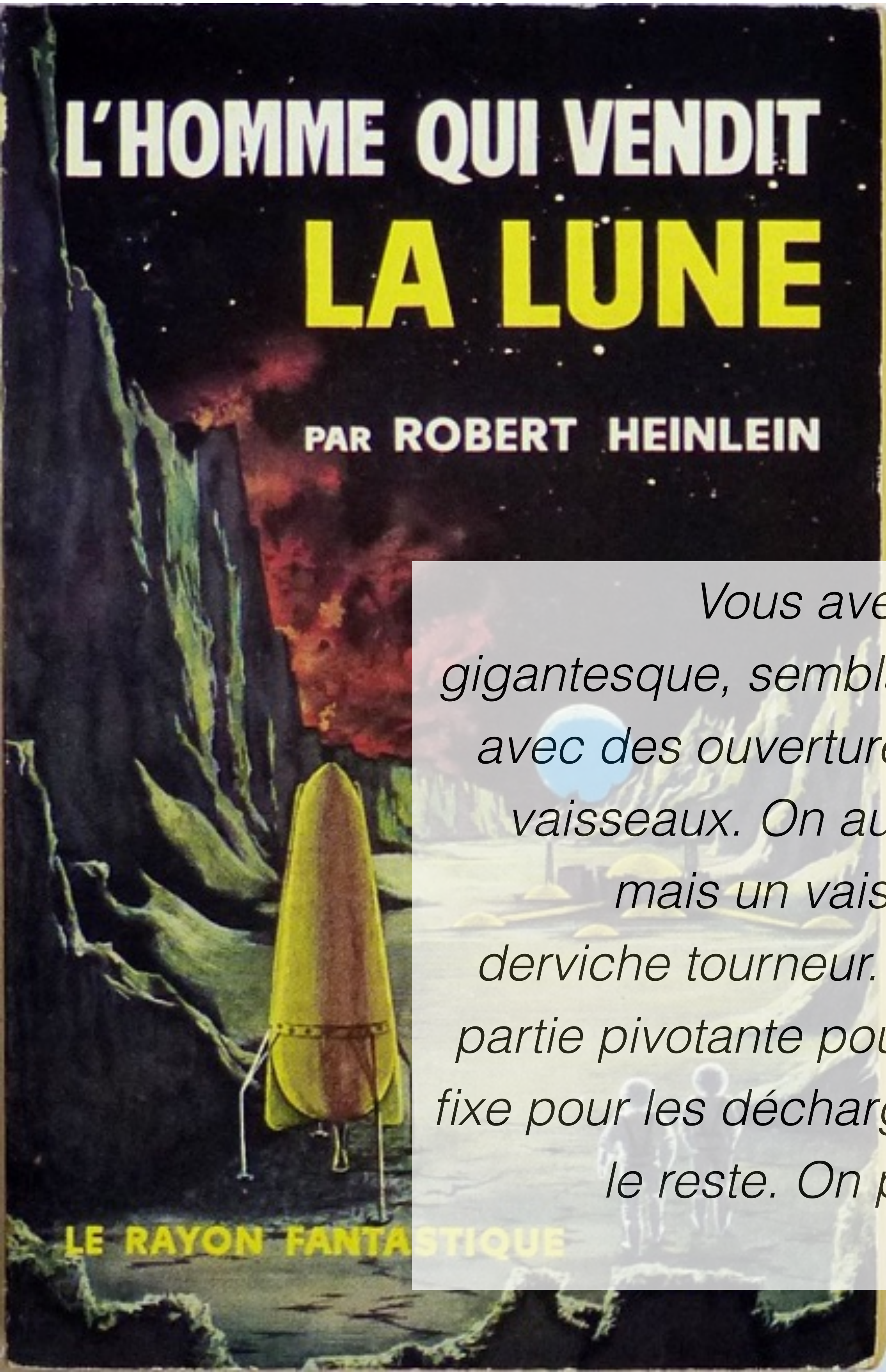
Such circling observatories can be manufactured at a cost much less than that of even a small cruiser; and the benefit that humanity would derive from such satellite observatories would pay for the investment in short order.

Of course, it would not be necessary for the observers to remain aloft permanently, as they could be relieved at any time by means of smaller space flyers. All that would be necessary is for a rocket-propelled ship to lay a course parallel to the observatory; after which the space ship can be made fast to the observatory. Then after an air-tight connection is effected, exchange of personnel can be made without trouble.

The benefits given above are only a few of those afforded by circling observatories. There are a hundred other important ones, which will easily suggest themselves; and we may be sure that, because the great importance of such space observatories, we will see them in use during the present century.

Editorial de Hugo Gernsback
Air Wonder Stories, avril 1930.

Robert A. Heinlein



Vous avez vu la station en photo – un cylindre gigantesque, semblable à une grosse caisse de batterie, avec des ouvertures pour livrer passage à la proue des vaisseaux. On aurait pu faire tourner la station entière, mais un vaisseau ne peut pas accoster contre un derviche tourneur. C'est pourquoi on avait construit une partie pivotante pour le confort de l'homme et une partie fixe pour les déchargements, les réservoirs, les dépôts et le reste. On passe de l'une à l'autre par le moyeu.

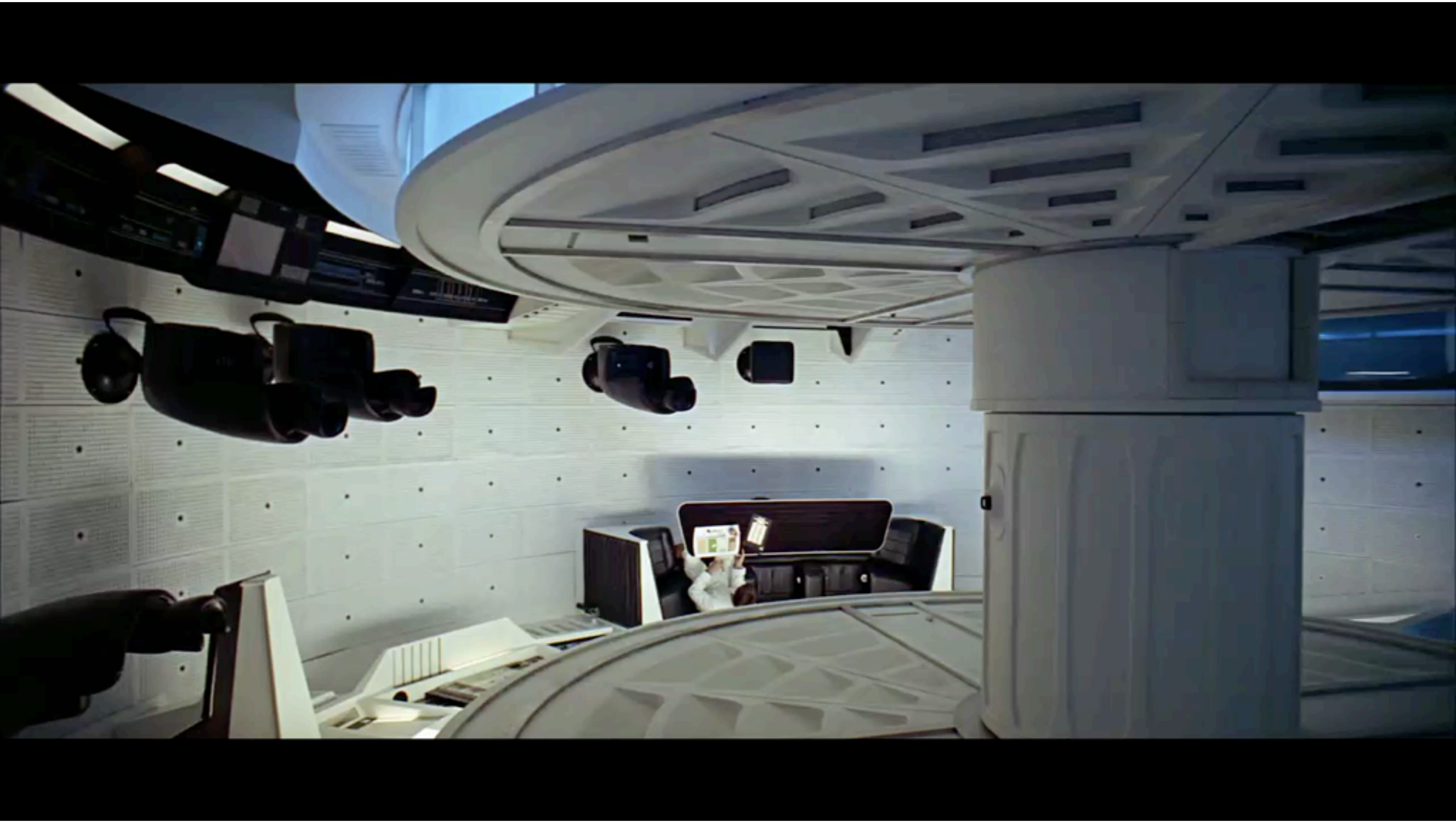
L'homme qui vendit la Lune (1950)

La roue orbitale

« La station spatiale sera aussi un hôtel, les astronautes pourront y vivre un mois ou deux de suite. Ils feront la navette entre la Terre et la station pour effectuer des travaux spéciaux. » - W. von Braun

Roue orbitale de 76 m de diamètre faisant 3 tours/minute (1/3 g), 80 personnes.

La gravité artificielle - 1



A l'intérieur du Discovery One ; *2001, l'Odyssée de l'espace* (Stanley Kubrick, 1968)

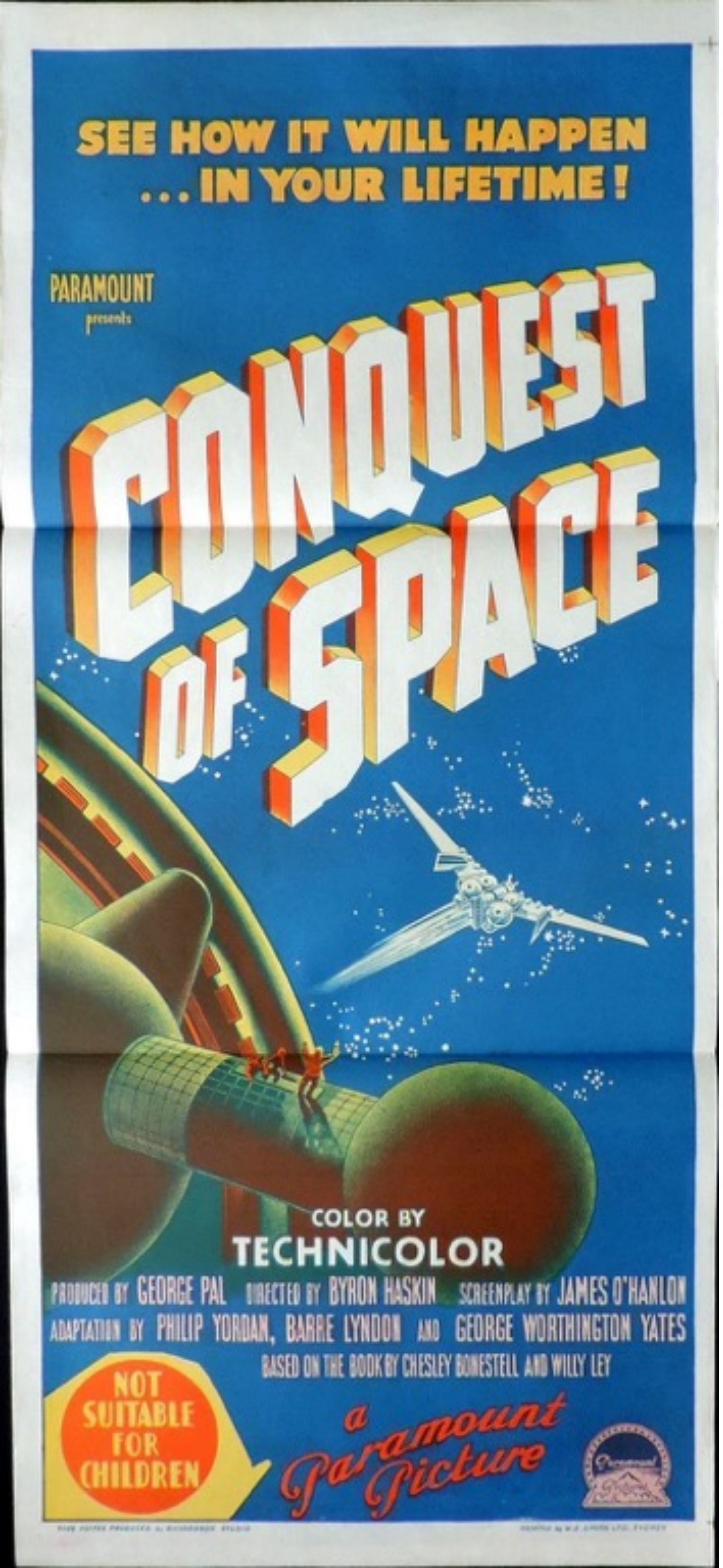
La gravité artificielle - 2

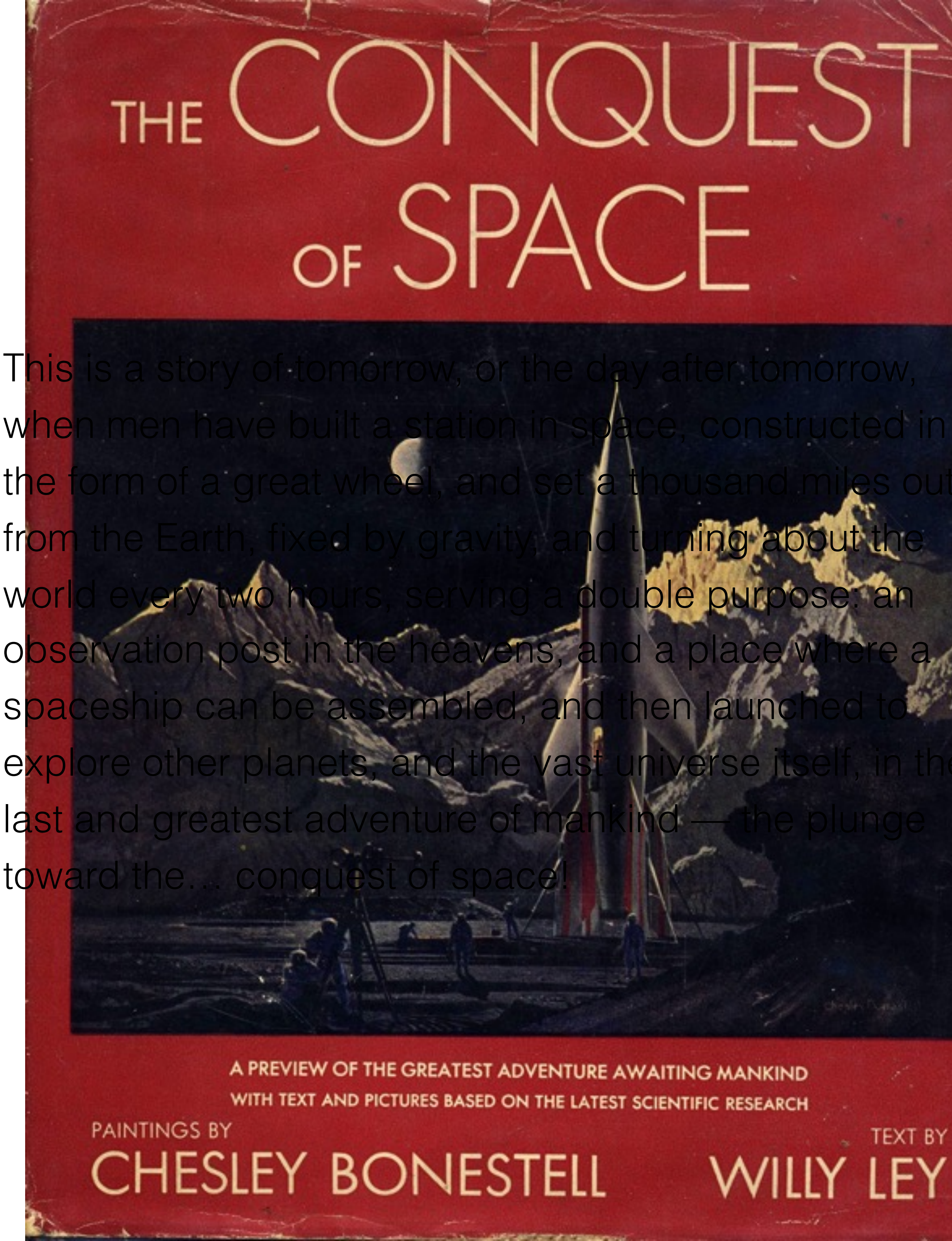
Simulateur d’une station en rotation (NASA Langley Research Center, 1966).

La Stratégie Ender (Gavin Hood, 2013)

– Où est le bas ? Quelqu'un peut me le dire ?
Ils le lui dirent.
– Le vaisseau tourne sur lui-même et c'est cela qui donne l'impression que le bas existe. En fait, le plancher décrit une courbe dans cette direction. Suivez cette courbe et vous reviendrez à l'endroit d'où vous êtes parti. (…)
Tout le centre de l'École de Guerre, le moyeu de la roue, est occupé par les salles de bataille. Elles ne tournent pas avec le reste de la station. C'est de cette façon qu'ils réalisent l'apesanteur. Pas de rotation, pas de bas. Mais il est possible d'amener les neuf salles de bataille devant l'entrée du couloir que nous utilisons tous. Lorsqu'on est à l'intérieur, ils déplacent l'ensemble et une autre salle se trouve en position.

Orson Scott Card, La stratégie Ender (1985).





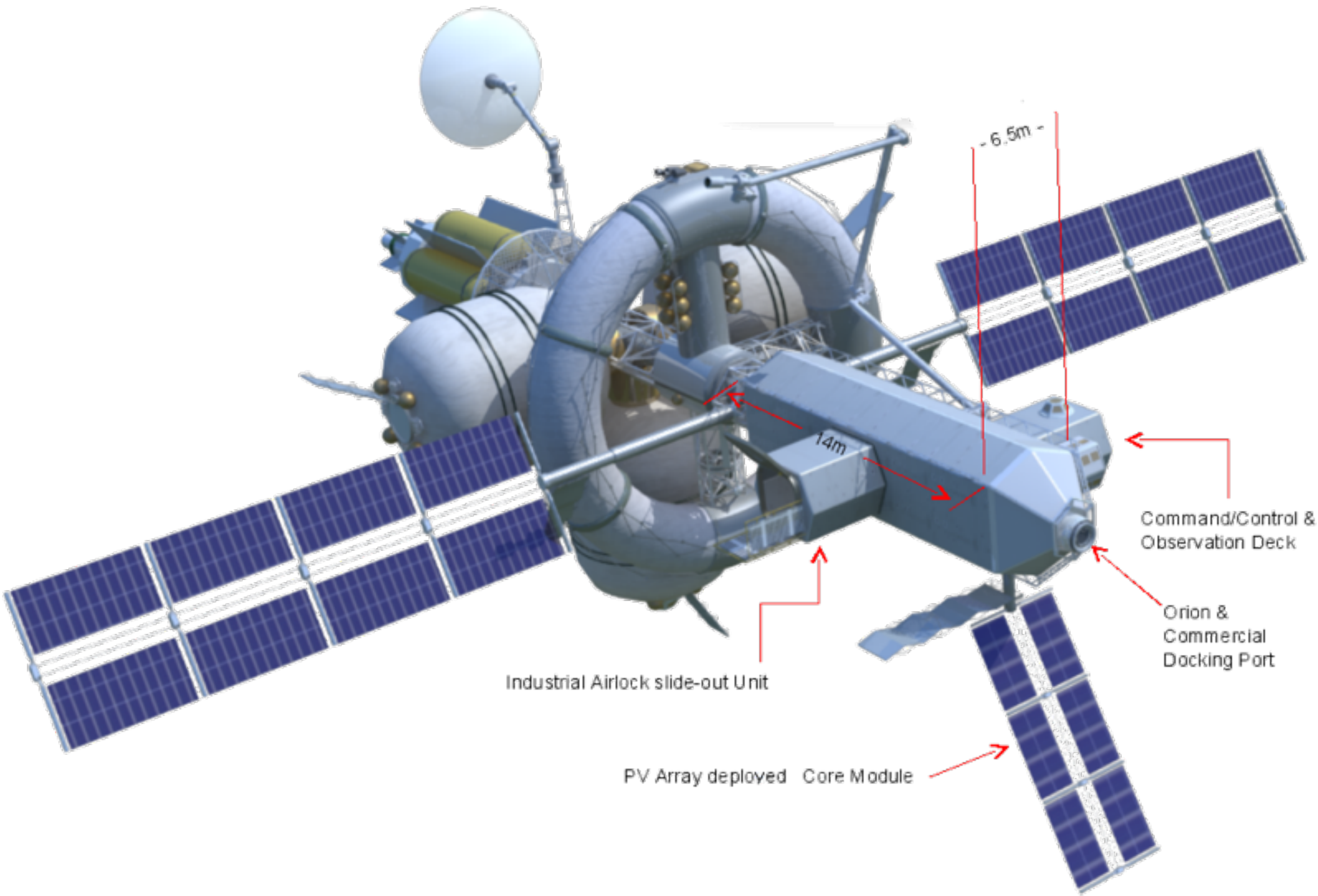
This is a story of tomorrow, or the day after tomorrow, when men have built a station in space, constructed in the form of a great wheel, and set a thousand miles out from the Earth, fixed by gravity and turning about the world every two hours, serving a double purpose: an observation post in the heavens, and a place where a spaceship can be assembled, and then launched to explore other planets, and the vast universe itself, in the last and greatest adventure of mankind — the plunge toward the… conquest of space!

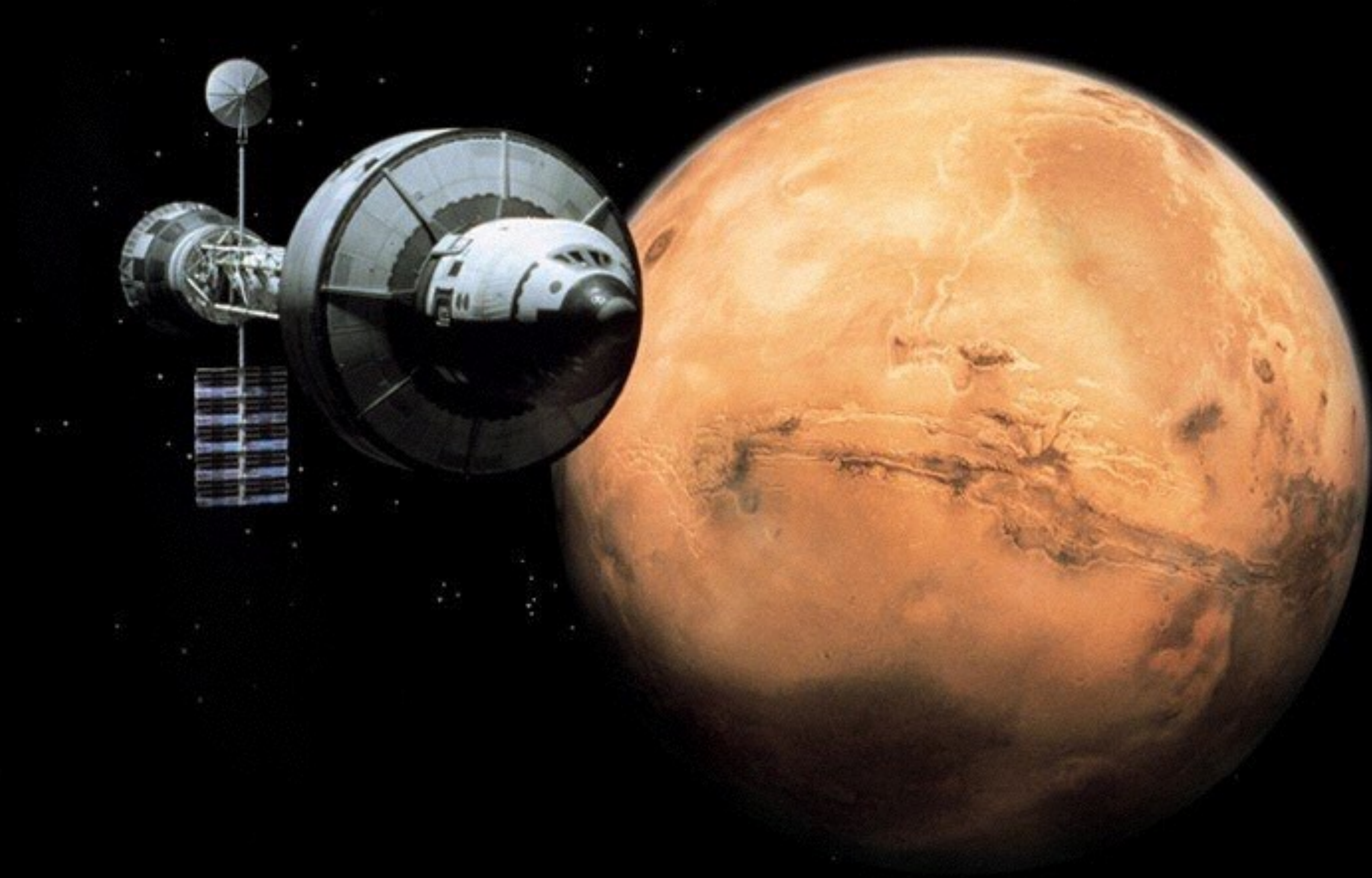
Isaac Asimov

Les vaisseaux spatiaux ne sont pas conçus pour faire face aux caprices d'une atmosphère dense, c'est pourquoi des planètes telles que la Terre et Vénus, entourées d'épaisses couches d'air, doivent disposer de stations orbitales pour accueillir les vaisseaux intersidéraux et permettre aux voyageurs de poursuivre leur course dans des caboteurs planétaires équipés d'ailes rétractables grâce auxquelles ils se jouent des courants d'air capricieux jusqu'à la surface de la planète.

David Starr (1952)

Le projet Nautilus-X (NASA, 2011)



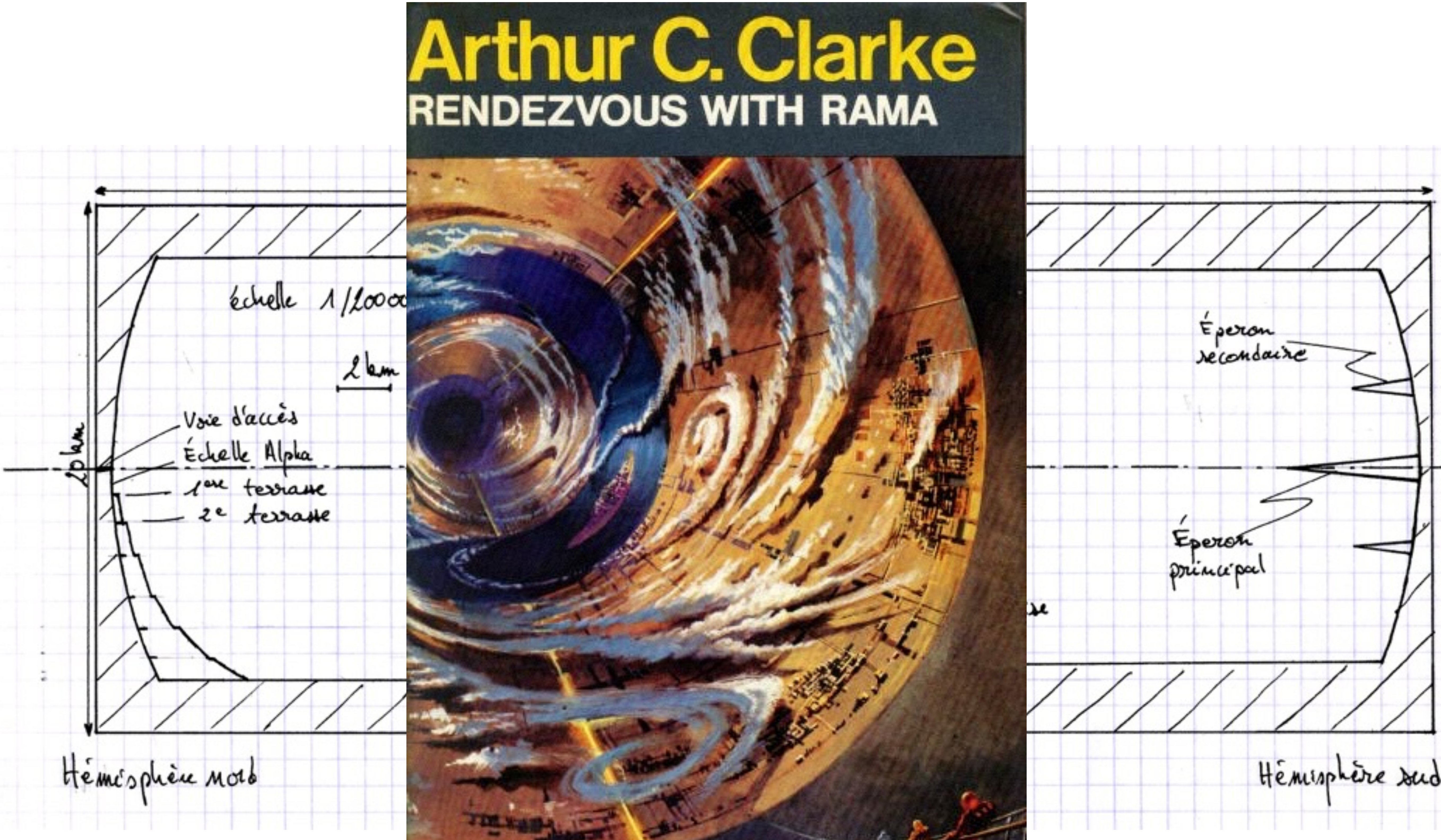


Le vaisseau de Mission to Mars (B. de Palma, 2000).

La station cylindrique

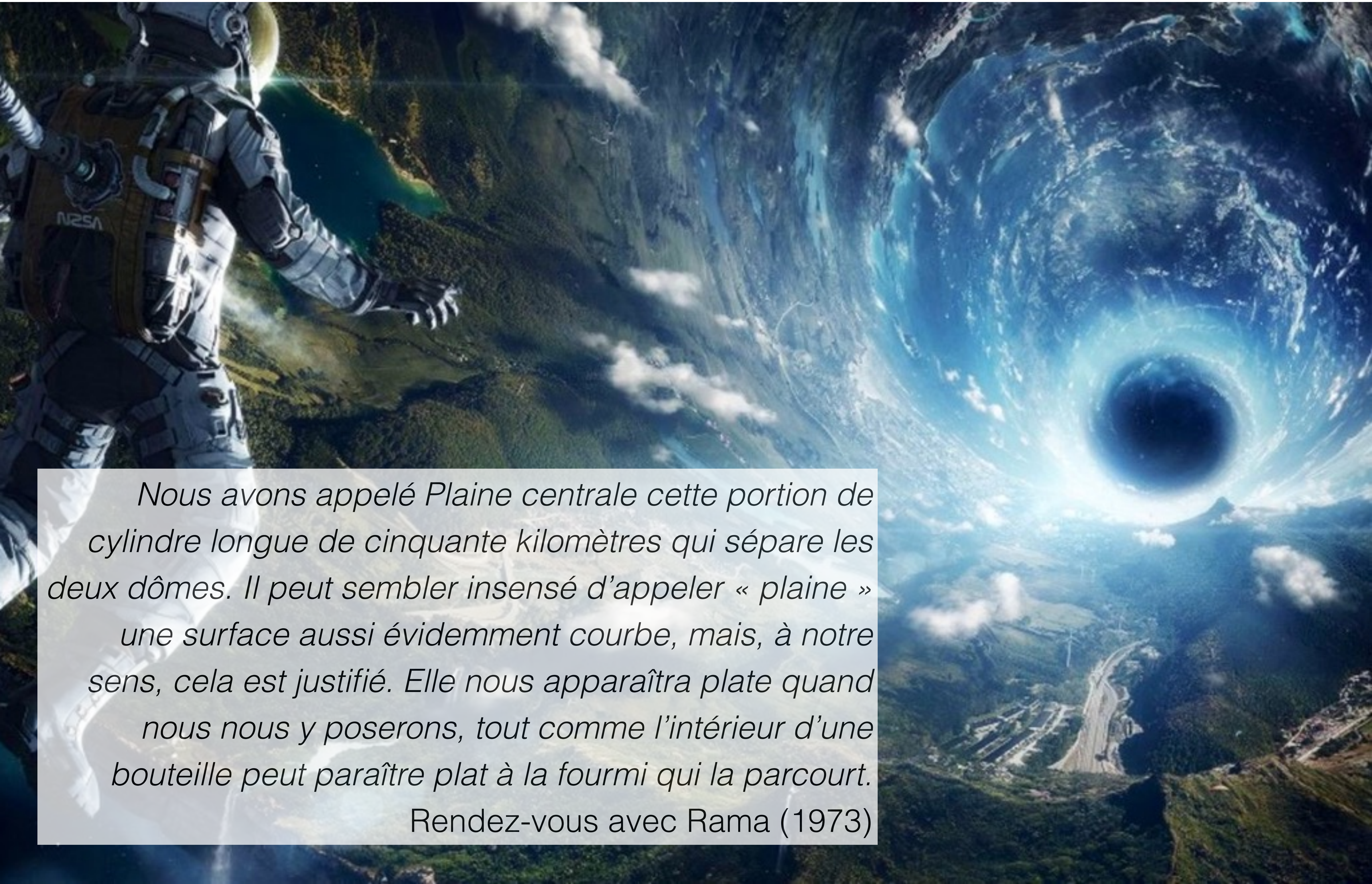
Vaisseau génération de Cole & Scarfo (1964) : 32 x 16 km.

Le vaisseau Rama (1973)



Vue intérieure 3D du vaisseau Rama
https://www.youtube.com/watch?v=UiO8CgGiWPM

Arthur C. Clarke



Nous avons appelé Plaine centrale cette portion de cylindre longue de cinquante kilomètres qui sépare les deux dômes. Il peut sembler insensé d'appeler « plaine » une surface aussi évidemment courbe, mais, à notre sens, cela est justifié. Elle nous apparaîtra plate quand nous nous y poserons, tout comme l'intérieur d'une bouteille peut paraître plat à la fourmi qui la parcourt.

Rendez-vous avec Rama (1973)

Le cylindre de O’Neill (1974)

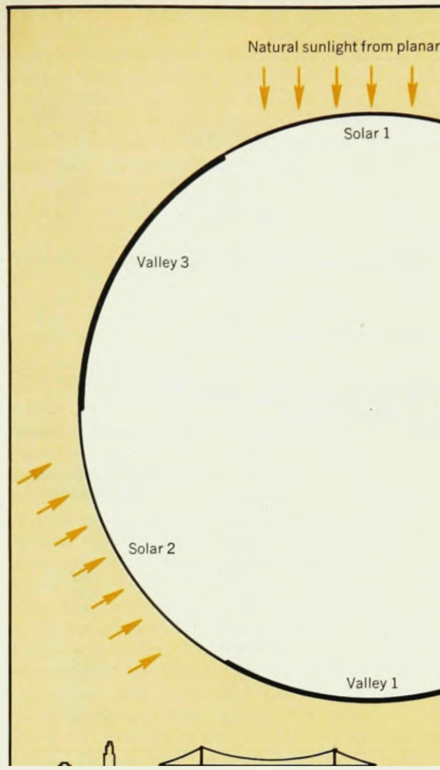


Table 1. Possible Stages in the Development of Space Communities

Model	Length (km)	Radius (m)	Period (sec)	Population*	Earliest estimated date
1	1	100	21	10 000	1988
2	3.2	320	36	100–200 × 10³	1996
3	10	1000	63	0.2–2 × 10⁶	2002
4	32	3200	114	0.2–20 × 10⁶	2008

* Population figures are for double unit; higher figures are the approximate ecological limits, for conventional agriculture.

Soil, rock and construction materials	420 000¹	—
Liquid hydrogen	5400	5400
2000 people and equipment	200	200
Dehydrated food	600	600
Totals	>500 000	10 000

¹ Includes replenishable reserves to be used to initiate construction of Model 2, and so are higher

natural sunlight, an earthlike appearance, efficient use of solar power and of materials. The most effective geometry satisfying all of these conditions appears to be a pair of cylinders. The economics of efficient us
tends to limit their size
miles in diameter, and pe
miles in length. (See
these cylinder pairs, th
area is devoted to living s
and forest, with lakes,
trees, animals and bird
ment like most attrac
Earth; agriculture is ca
where. The circumfere
into alternating strips
("valleys") and window a
The rotation period is tw
the cylinder axes are a
toward the Sun.
Because the Moon is
both of titanium and of a
likely that these metals w
tensively in the colonies.
tism, though, the calcula
inder structure has been
use of steel cables, to for
(longitudinal members c
mospheric forces on the
circumferential bands (c
mospheric force and the
weights of the ground, of
and of themselves. For
calculation and the assu
cludes, see the box on p
steel cables are bunche
coarse mesh in the windo
bands there subtend a
2.3 × 10⁻⁴ radians, abou
diffraction limit for the s
ed human eye, and so are

The colonization of space

Careful engineering and cost analysis shows we can build pleasant, self-sufficient dwelling places in space within the next two decades, solving many of Earth’s problems.

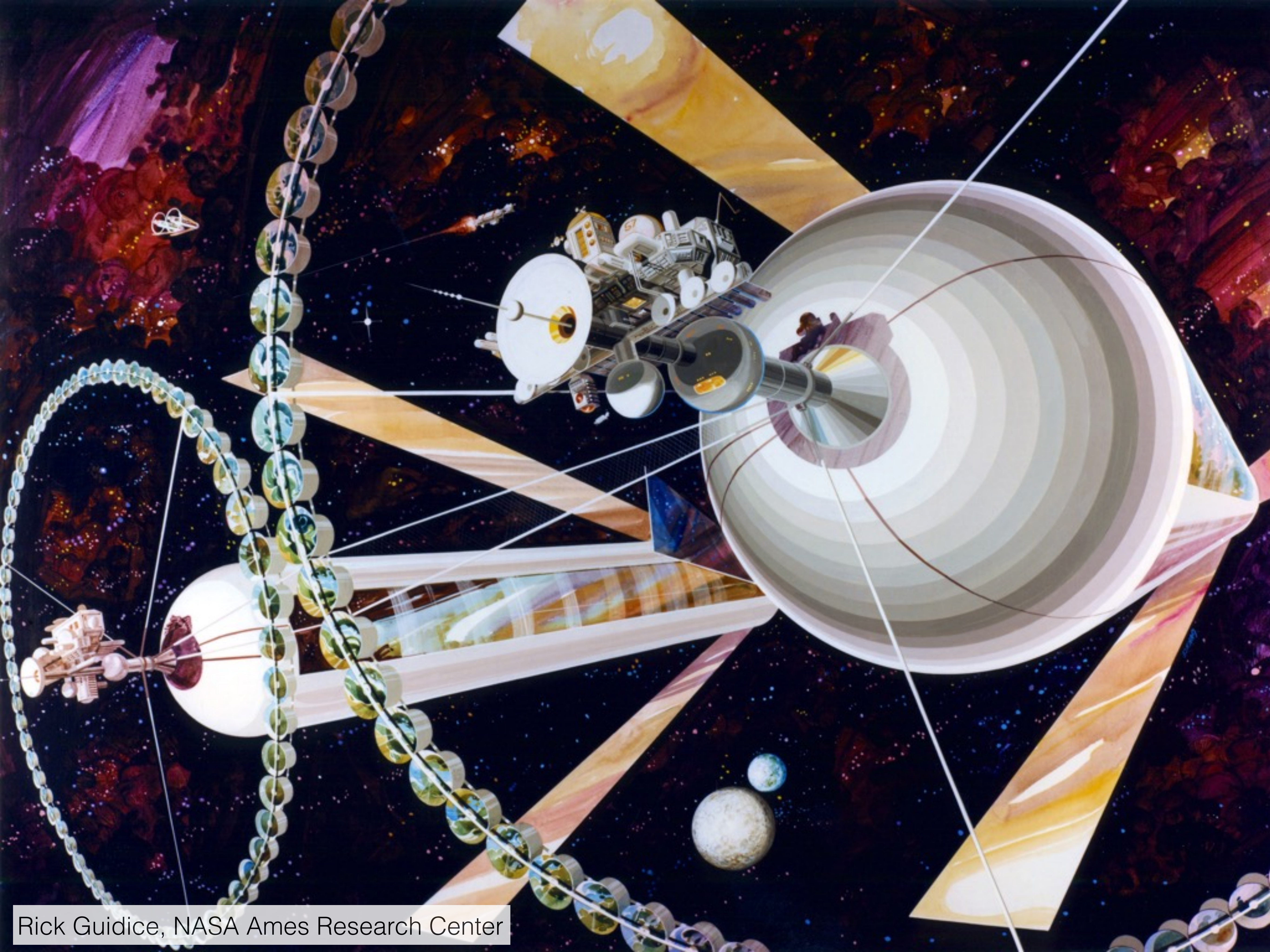
Gerard K. O’Neill

The length of a day in each community is controlled by opening and closing the main mirrors that rotate with the cylinders. The length of day then sets the average temperature and seasonal variation within the cylinder. Each
thought of as a heat
o 3 × 10⁸ tons of water;
it exchange, the warm-
aylight would be about
our. As on Earth, the
e is higher because the
an a few centimeters
e does not follow the

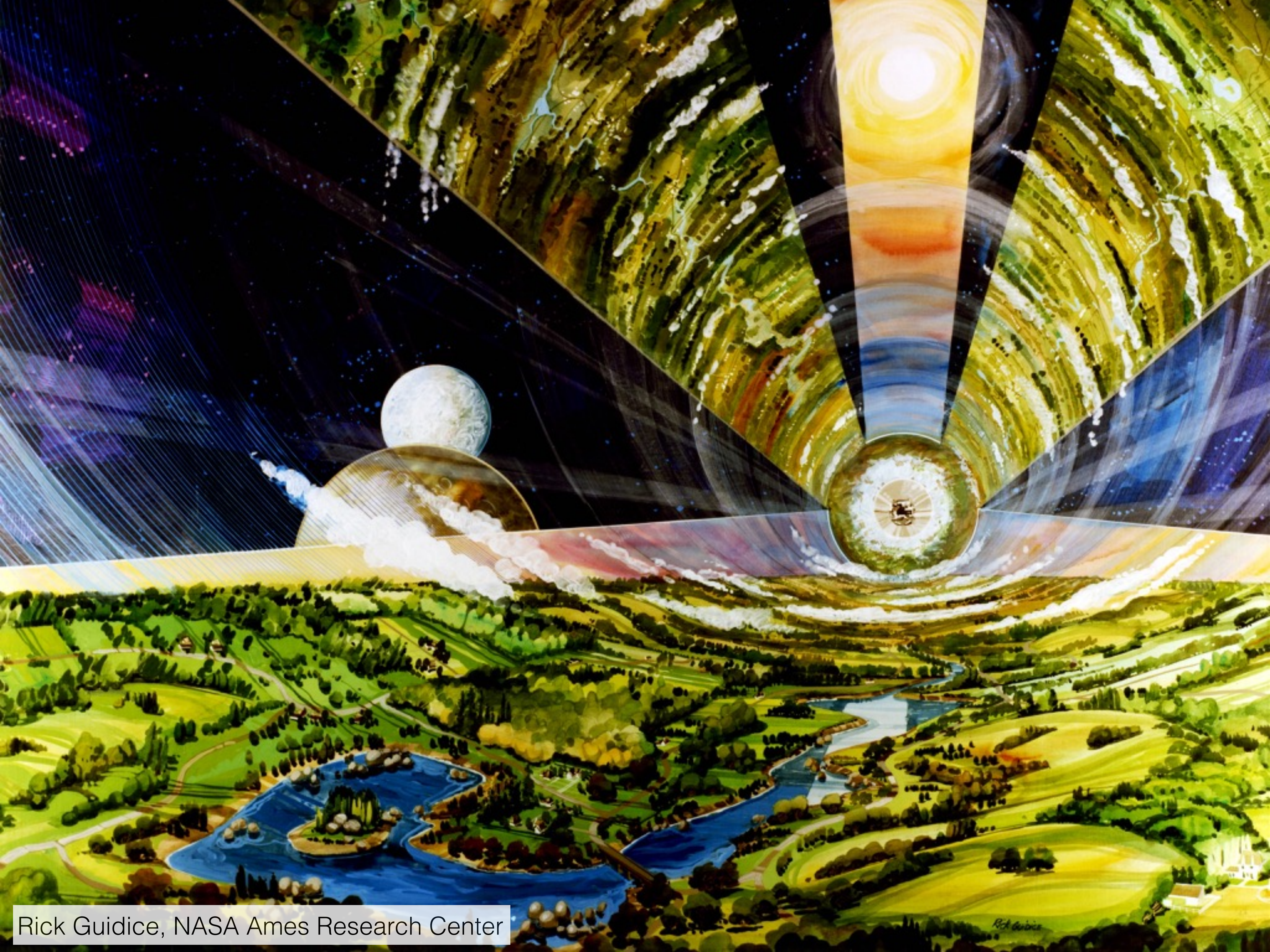
al species that are en-
th by agricultural and
cal residues may find
h in the space colonies,
s are unnecessary, ag-
are physically separate
, and industry has un-
r recycling.
n figure 1, it is possible
in Earth features: the
is taken from an aerial
section of the Grand
Wyoming. The calcu-
heights as seen in the
of summer weather on
adiabatic lapse rate of
neters and a dew-point
6 deg per 300 meters,
nidity and a tempera-
en zero and 32°C, the
ts range between 1100

ntrol

al areas are separate
reas, and each one has
for the particular crop
avity, atmosphere and



Rick Guidice, NASA Ames Research Center



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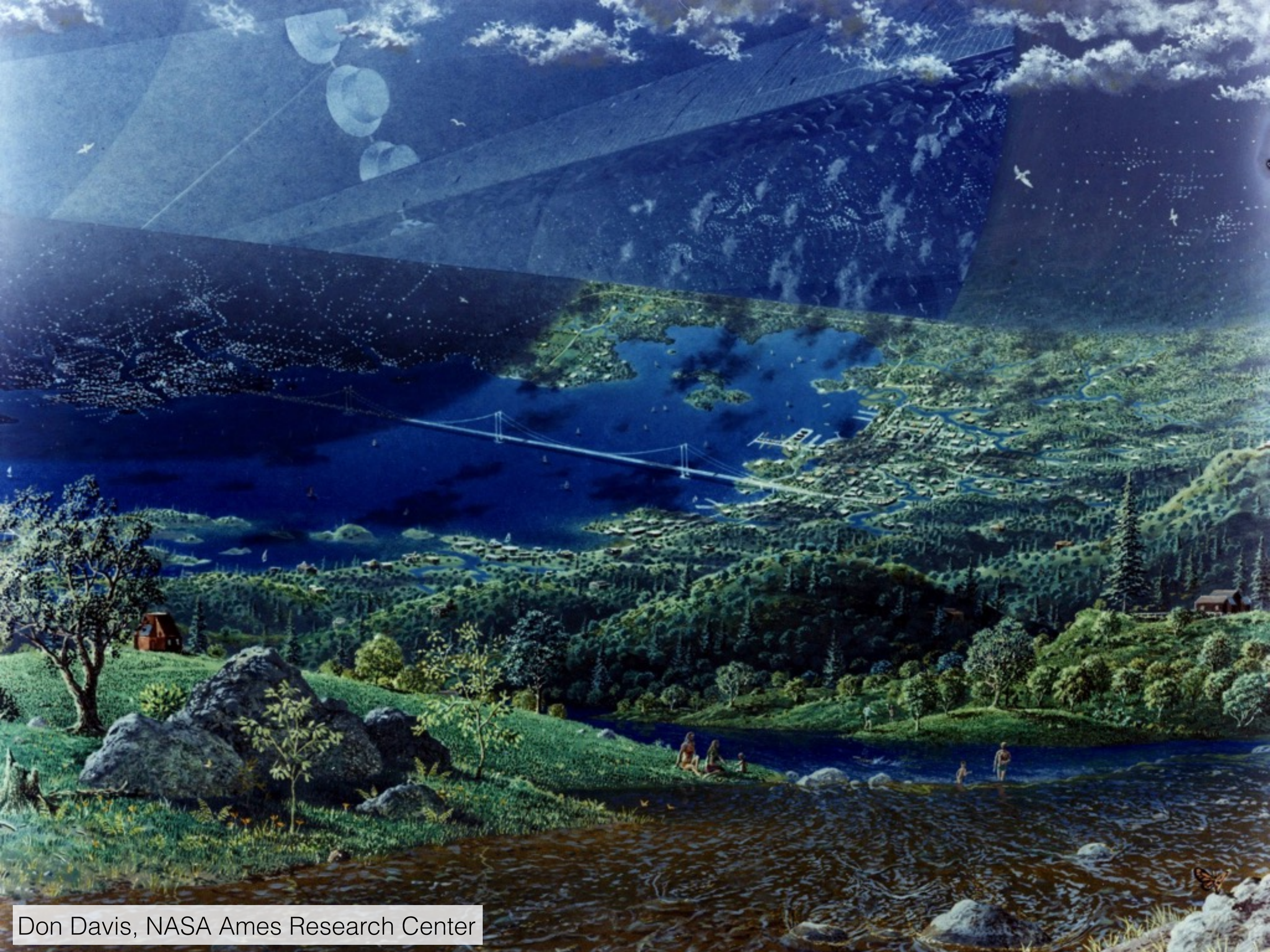


Don Davis, NASA Ames Research Center

La station Cooper

Vue intérieure de la station Cooper, en orbite autour de Saturne (Interstellar, 2014).

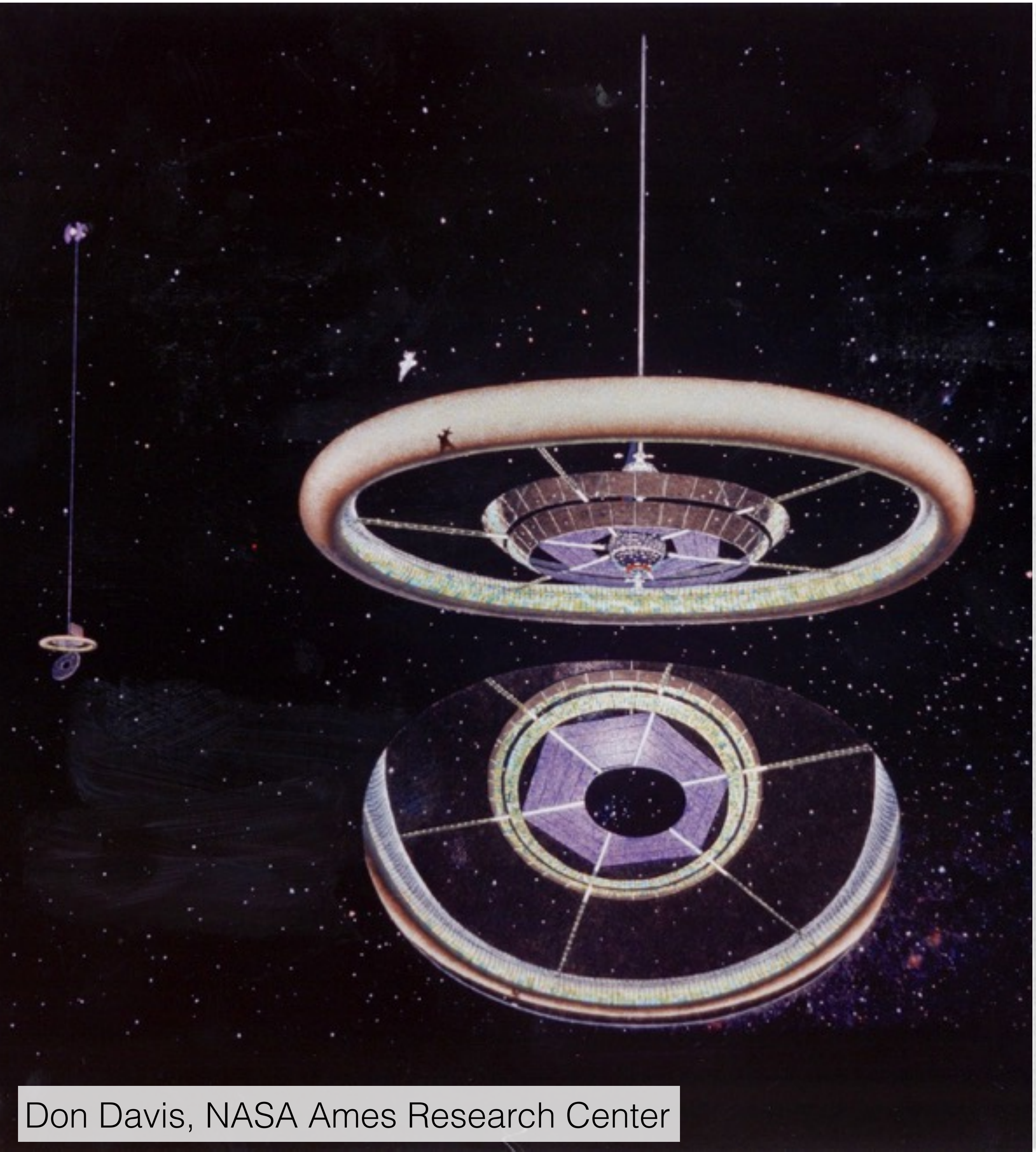
L’installation Veggie de l’ISS

Expérience de culture végétales à bord de l’ISS (octobre 2017).

La station Cooper

Joueurs de base-ball dans la station Cooper, en orbite autour de Saturne.

Le tore de Stanford (1975)



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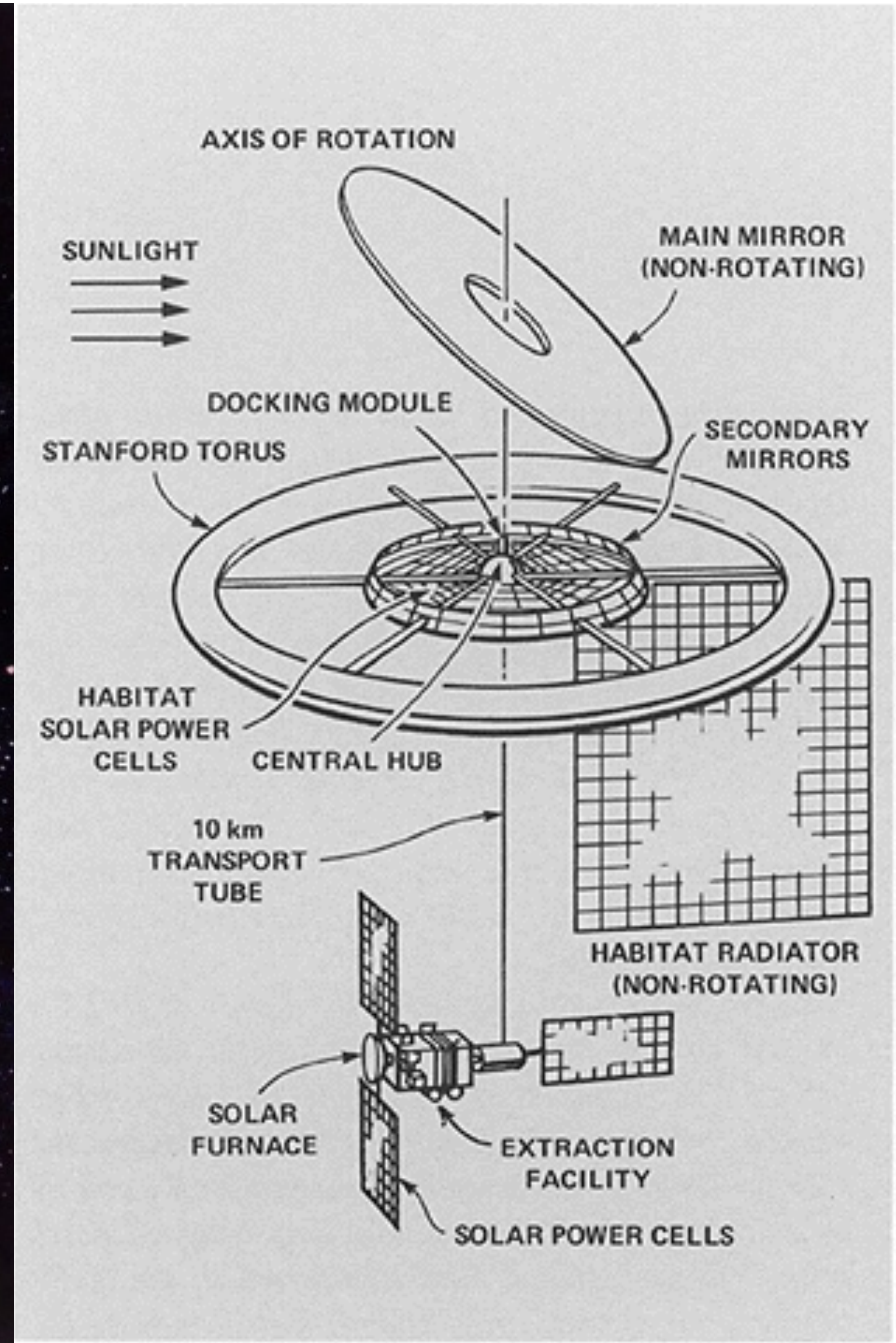
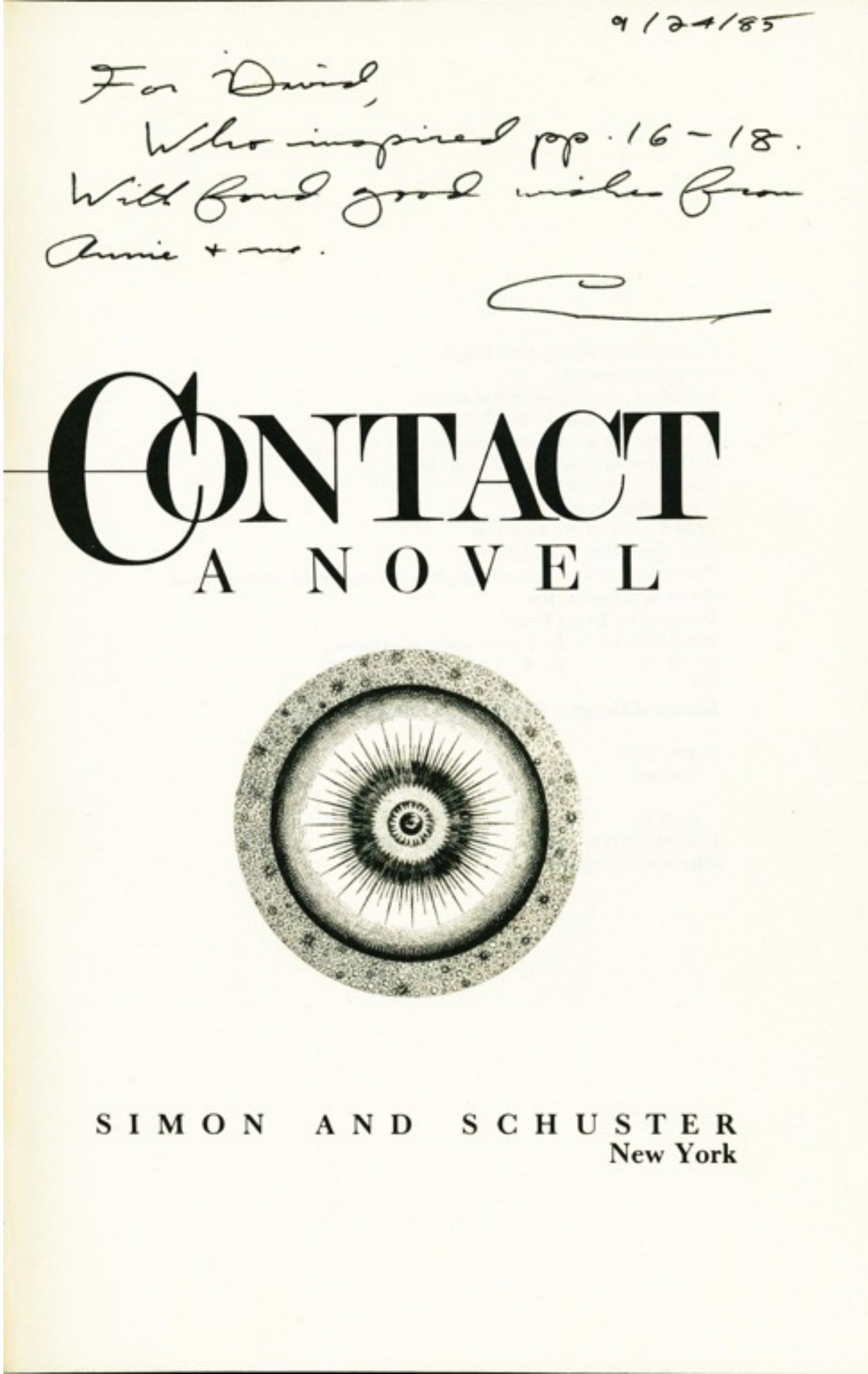


Don Davis, NASA Ames Research Center

Rick Guidice, NASA Ames Research Center

La station Elysium

(Neill Blomkamp, 2013)



9/24/85

For David,
Who inspired pp. 16–18.
With fond good wishes from
Annie + me.

CONTACT
A NOVEL

SIMON AND SCHUSTER
New York

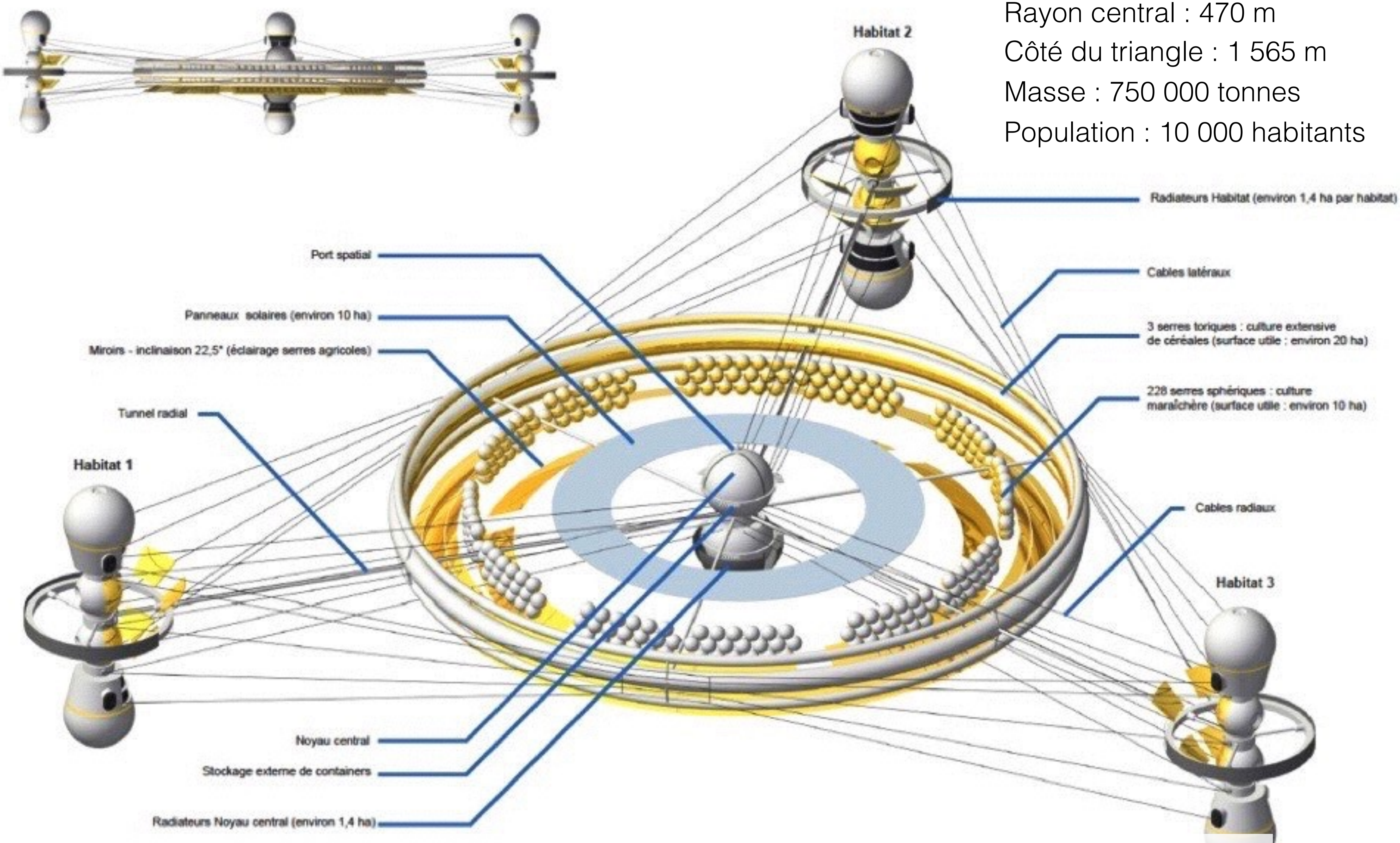
Carl Sagan

Les premières et rudimentaires maisons de retraite spatiales, à quelques centaines de kilomètres d'altitude, furent opérationnelles dans les toutes dernières années du deuxième millénaire. En dehors du coût, il existait un autre inconvénient grave : les dommages entraînés par l'apesanteur sur les os et le système vasculaire rendaient impossible tout retour dans le champ gravitationnel de la surface de la Terre. Mais pour certains riches vieillards, ce n'était qu'un inconvénient mineur : en échange d'une décennie de vie de plus, ils étaient trop heureux de prendre leur retraite dans le ciel, pour finalement y mourir.

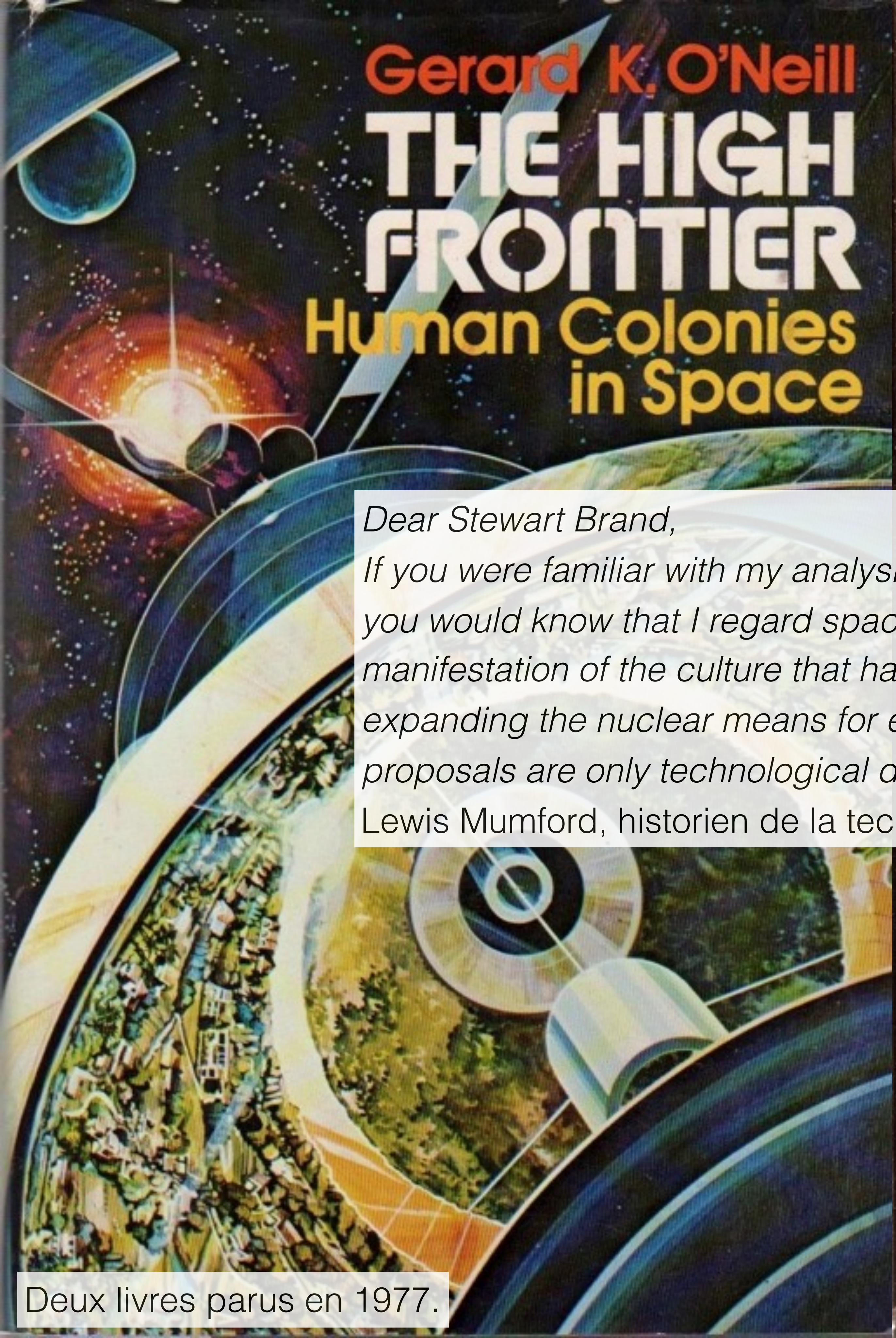
Contact (1985)

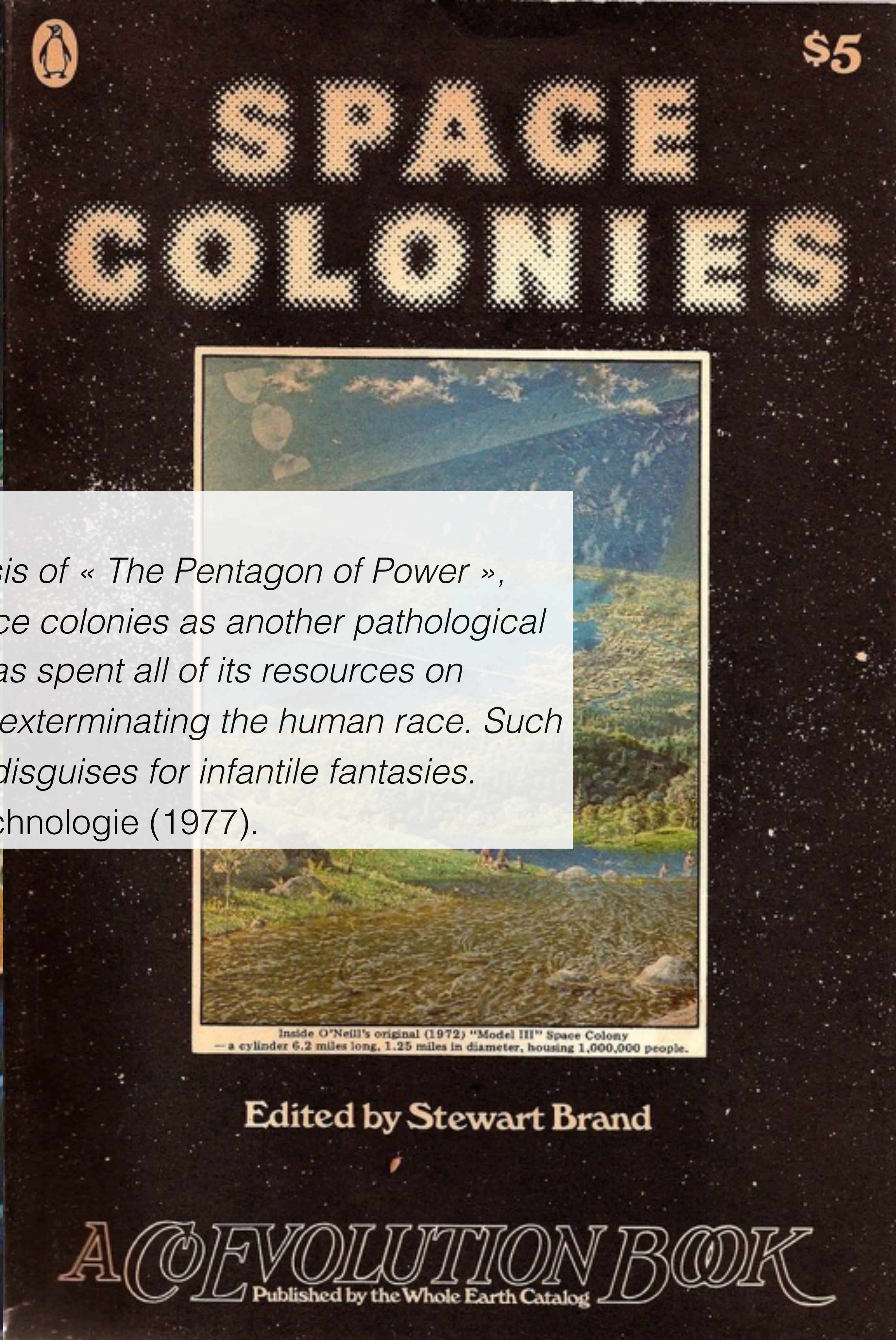
La station Apogeios (2011)

Rayon central : 470 m
Côté du triangle : 1 565 m
Masse : 750 000 tonnes
Population : 10 000 habitants



Concept du à deux ingénieurs français, Pierre Marx et Olivier Boisard (http://www.planete-a-roulettes.net/APO/fr/)





Dear Stewart Brand,
If you were familiar with my analysis of « The Pentagon of Power », you would know that I regard space colonies as another pathological manifestation of the culture that has spent all of its resources on expanding the nuclear means for exterminating the human race. Such proposals are only technological disguises for infantile fantasies.
Lewis Mumford, historien de la technologie (1977).

Deux livres parus en 1977.

Manchu (2014)