

为什么要探索宇宙？

In 1970, a Zambia-based nun named Sister Mary Jucunda wrote to Dr. Ernst Stuhlinger, then-associate director of science at NASA's Marshall Space Flight Center, in response to his ongoing research into a piloted mission to Mars. Specifically, she asked how he could suggest spending billions of dollars on such a project at a time when so many children were starving on Earth.

1970年，赞比亚修女 Mary Jucunda 给 Ernst Stuhlinger 博士写了一封信，他因在火星之旅工程中的原创性研究，成为 NASA（美国航空航天局）Marshall 太空航行中心的科学副总监。信中，Mary Jucunda 修女问道：目前地球上还有这么多小孩子吃不上饭，他怎么能舍得为远在火星的项目花费数十亿美元。

Stuhlinger soon sent the following letter of explanation to Sister Jucunda, along with a copy of "Earthrise," the iconic photograph of Earth taken in 1968 by astronaut William Anders, from the Moon (also embedded in the transcript). His thoughtful reply was later published by NASA, and titled, "Why Explore Space?"

Stuhlinger 很快给 Jucunda 修女回了信，同时还附带了一张题为“升起的地球”的照片，这张标志性的照片是宇航员 William Anders 于 1968 年在月球轨道上拍摄的（照片中可以看到月球的地面）。他这封真挚的回信随后由 NASA 以《为什么要探索宇宙》为标题发表。



May 6, 1970

1970年5月6日

Dear Sister Mary Jucunda:

亲爱的 Mary Jucunda 修女:

Your letter was one of many which are reaching me every day, but it has touched me more deeply than all the others because it came so much from the depths of a searching mind and a compassionate heart. I will try to answer your question as best as I possibly can.

每天，我都会收到很多类似的来信，但这封对我的触动最深，因为它来自一颗慈悲的饱含探求精神的心灵。我会尽自己所能来回答你这个问题。

First, however, I would like to express my great admiration for you, and for all your many brave sisters, because you are dedicating your lives to the noblest cause of man: help for his fellowmen who are in need.

首先，请允许我向你以及你勇敢的姐妹们表达深深的敬意，你们献身于人类最崇高的事业：帮助身处困境的同胞。

You asked in your letter how I could suggest the expenditures of billions of dollars for a voyage to Mars, at a time when many children on this Earth are starving to death. I know that you do not expect an answer such as "Oh, I did not know that there are children dying from hunger, but from now on I will desist from any kind of space research until mankind has solved that problem!" In fact, I have known of famined children long before I knew that a voyage to the planet Mars is technically feasible. However, I believe, like many of my friends, that travelling to the Moon and eventually to Mars and to other planets is a venture which we should undertake now, and I even believe that this project, in the long run, will contribute more to the solution of these grave problems we are facing here on Earth than many other potential projects of help which are debated and discussed year after year, and which are so extremely slow in yielding tangible results.

在来信中，你问我在目前地球上还有儿童由于饥饿面临死亡威胁的情况下，为什么还要花费数十亿美元来进行飞向火星的航行。我清楚你肯定不希望这样的答案：“哦，我之前不知道还有小孩子快饿死了，好吧，从现在开始，暂停所有的太空项目，直到孩子们都吃上饭再说。”事实上，早在了解火星之旅的技术之前，我已经对儿童的饥荒问题有所了解。而且，同我很多朋友的想法一样，我认为此时此刻，我们就应该开始通往月球、火星乃至其他行星的伟大探险。从长远来看，相对于那些要么只有年复一年的辩论和争吵，要么连妥协之后也迟迟无法落实的各种援助计划来说，我甚至觉得探索太空的工程给更有助于解决人类目前所面临的种种危机。

Before trying to describe in more detail how our space program is contributing to the solution of our Earthly problems, I would like to relate briefly a supposedly true story, which may help

support the argument. About 400 years ago, there lived a count in a small town in Germany. He was one of the benign counts, and he gave a large part of his income to the poor in his town. This was much appreciated, because poverty was abundant during medieval times, and there were epidemics of the plague which ravaged the country frequently. One day, the count met a strange man. He had a workbench and little laboratory in his house, and he labored hard during the daytime so that he could afford a few hours every evening to work in his laboratory. He ground small lenses from pieces of glass; he mounted the lenses in tubes, and he used these gadgets to look at very small objects. The count was particularly fascinated by the tiny creatures that could be observed with the strong magnification, and which he had never seen before. He invited the man to move with his laboratory to the castle, to become a member of the count's household, and to devote henceforth all his time to the development and perfection of his optical gadgets as a special employee of the count.

在详细说明我们的太空项目如何帮助解决地面上的危机之前，我想先简短讲一个真实的故事。那是在 400 年前，德国某小镇里有一位伯爵。他是个心地善良的人，他将自己收入的一大部分捐给了镇子上的穷人。这十分令人钦佩，因为中世纪时穷人很多，而且那时经常爆发席卷全国的瘟疫。一天，伯爵碰到了一个奇怪的人，他家中有一个工作台和一个小实验室，他白天卖力工作，每天晚上的几小时的时间专心进行研究。他把小玻璃片研磨成镜片，然后把研磨好的镜片装到镜筒里，用此来观察细小的物件。伯爵被这个前所未见的可以把东西放大观察的小发明迷住了。他邀请这个怪人住到了他的城堡里，作为伯爵的门客，此后他可以专心投入所有的时间来研究这些光学器件。

The townspeople, however, became angry when they realized that the count was wasting his money, as they thought, on a stunt without purpose. "We are suffering from this plague," they said, "while he is paying that man for a useless hobby!" But the count remained firm. "I give you as much as I can afford," he said, "but I will also support this man and his work, because I know that someday something will come out of it!"

然而，镇子上的人得知伯爵在这么一个怪人和他那些无用的玩意儿上花费金钱之后，都很生气，“我们还在受瘟疫的苦”，他们抱怨道，“而他却为那个闲人和他没用的爱好乱花钱！”伯爵听到后不为所动，“我会尽可能地接济大家”，他表示，“但我会继续资助这个人和他的工作，我确信终有一天会有回报。”

Indeed, something very good came out of this work, and also out of similar work done by others at other places: the microscope. It is well known that the microscope has contributed more than any other invention to the progress of medicine, and that the elimination of the plague and many other contagious diseases from most parts of the world is largely a result of studies which the microscope made possible.

果不其然，他的工作赢来了丰厚的回报：显微镜。显微镜的发明给医学带来了前所未有的发展，由此展开的研究及其成果，消除了世界上大部分地区肆虐的瘟疫和其他一些传染性疾病。

The count, by retaining some of his spending money for research and discovery, contributed far more to the relief of human suffering than he could have contributed by giving all he could

possibly spare to his plague-ridden community.

伯爵为支持这项研究发明所花费的金钱，其最终结果大大减轻了人类所遭受的苦难，这回报远远超过单纯将这些钱用来救济那些遭受瘟疫的人。

The situation which we are facing today is similar in many respects. The President of the United States is spending about 200 billion dollars in his yearly budget. This money goes to health, education, welfare, urban renewal, highways, transportation, foreign aid, defense, conservation, science, agriculture and many installations inside and outside the country. About 1.6 percent of this national budget was allocated to space exploration this year. The space program includes Project Apollo, and many other smaller projects in space physics, space astronomy, space biology, planetary projects, Earth resources projects, and space engineering. To make this expenditure for the space program possible, the average American taxpayer with 10,000 dollars income per year is paying about 30 tax dollars for space. The rest of his income, 9,970 dollars, remains for his subsistence, his recreation, his savings, his other taxes, and all his other expenditures.

我们目前面临类似的问题。美国总统的年度预算共有 2000 亿美元，这些钱将用于医疗、教育、福利、城市建设、高速公路、交通运输、海外援助、国防、环保、科技、农业以及其他多项国内外的工程。今年，预算中的 1.6% 将用于探索宇宙，这些花销将用于阿波罗以计划、其他一些涵盖了天体物理学、深空天文学、空间生物学、行星探测工程、地球资源工程的小项目以及空间工程技术。为担负这些太空项目的支出，平均每个年收入 10,000 美元的美国纳税人需要支付约 30 美元给太空，剩下的 9,970 美元则可用于一般生活开支、休闲娱乐、储蓄、别的税项等花销。

You will probably ask now: "Why don't you take 5 or 3 or 1 dollar out of the 30 space dollars which the average American taxpayer is paying, and send these dollars to the hungry children?" To answer this question, I have to explain briefly how the economy of this country works. The situation is very similar in other countries. The government consists of a number of departments (Interior, Justice, Health, Education and Welfare, Transportation, Defense, and others) and the bureaus (National Science Foundation, National Aeronautics and Space Administration, and others). All of them prepare their yearly budgets according to their assigned missions, and each of them must defend its budget against extremely severe screening by congressional committees, and against heavy pressure for economy from the Bureau of the Budget and the President. When the funds are finally appropriated by Congress, they can be spent only for the line items specified and approved in the budget.

也许你会问：“为什么不从纳税人为太空支付的 30 美元里抽出 5 美元或 3 美元或是 1 美元来救济饥饿的儿童呢？”为了回答这个问题，我需要先简单解释一下我们国家的经济是如何运行的，其他国家也是类似的情形。政府由几个部门（如内政部、司法部、卫生部与公众福利部、教育部、运输部、国防部等）和几个机构（国家科学基金会、国家航空航天局等）组成，这些部门和机构根据自己的职能制定相应的年度预算，并严格执行以应对国务委员会的监督，同时还要应付来自预算部门和总统对于其经济效益的压力。当资金最终由国会拨出后，将严格用于经预算批准的计划中的项目。

The budget of the National Aeronautics and Space Administration, naturally, can contain only items directly related to aeronautics and space. If this budget were not approved by Congress, the funds proposed for it would not be available for something else; they would simply not be levied from the taxpayer, unless one of the other budgets had obtained approval for a specific increase which would then absorb the funds not spent for space. You realize from this brief discourse that support for hungry children, or rather a support in addition to what the United States is already contributing to this very worthy cause in the form of foreign aid, can be obtained only if the appropriate department submits a budget line item for this purpose, and if this line item is then approved by Congress.

显然，NASA 的预算中所包含的项目都是和航空航天有关的。未经国会批准的预算项目，是不会得到资金支持的，自然也不会被课税，除非有其他部门的预算涵盖了该项目，借此花掉没有分配给太空项目的资金。由这段简短的说明可以看出，要想援助饥饿的儿童，或在美国已有的对外援助项目上增加援助金额，需要首先由相关部门提出预算，然后由国会批准才行。

You may ask now whether I personally would be in favor of such a move by our government. My answer is an emphatic yes. Indeed, I would not mind at all if my annual taxes were increased by a number of dollars for the purpose of feeding hungry children, wherever they may live.

要问是否同意政府实施类似的政策，我个人的意见是绝对赞成。我完全不介意每年多付出一点点税款来帮助饥饿的儿童，无论他们身在何处。

I know that all of my friends feel the same way. However, we could not bring such a program to life merely by desisting from making plans for voyages to Mars. On the contrary, I even believe that by working for the space program I can make some contribution to the relief and eventual solution of such grave problems as poverty and hunger on Earth. Basic to the hunger problem are two functions: the production of food and the distribution of food. Food production by agriculture, cattle ranching, ocean fishing and other large-scale operations is efficient in some parts of the world, but drastically deficient in many others. For example, large areas of land could be utilized far better if efficient methods of watershed control, fertilizer use, weather forecasting, fertility assessment, plantation programming, field selection, planting habits, timing of cultivation, crop survey and harvest planning were applied.

我相信我的朋友们也会持相同的态度。然而，事情并不是仅靠把去往火星航行的计划取消就能轻易实现的。相对的，我甚至认为可以通过太空项目，来为缓解乃至最终解决地球上的贫穷和饥饿问题作出贡献。解决饥饿问题的关键有两部分：食物的生产和食物的发放。食物的生产所涉及的农业、畜牧业、渔业及其他大规模生产活动在世界上的一些地区高效高产，而在有的地区则产量严重不足。通过高科技手段，如灌溉管理，肥料的使用，天气预报，产量评估，程序化种植，农田优选，作物的习性与耕作时间选择，农作物调查及收割计划，可以显著提高土地的生产效率。

The best tool for the improvement of all these functions, undoubtedly, is the artificial Earth satellite. Circling the globe at a high altitude, it can screen wide areas of land within a short time; it can observe and measure a large variety of factors indicating the status and condition of crops,

soil, droughts, rainfall, snow cover, etc., and it can radio this information to ground stations for appropriate use. It has been estimated that even a modest system of Earth satellites equipped with Earth resources, sensors, working within a program for worldwide agricultural improvements, will increase the yearly crops by an equivalent of many billions of dollars.

人造地球卫星无疑是改进这两个关键问题最有力的工具。在远离地面的运行轨道上，卫星能够在很短的时间里扫描大片的陆地，可以同时观察计算农作物生长所需要的多项指标，土壤、旱情、雨雪天气等等，并且可以将这些信息广播至地面接收站以便做进一步处理。据估算，配备有土地资源传感器及相应的农业程序的人造卫星系统，即便是最简单的型号，也能给农作物的年产量带来数以十亿美元计的提升。

The distribution of the food to the needy is a completely different problem. The question is not so much one of shipping volume, it is one of international cooperation. The ruler of a small nation may feel very uneasy about the prospect of having large quantities of food shipped into his country by a large nation, simply because he fears that along with the food there may also be an import of influence and foreign power. Efficient relief from hunger, I am afraid, will not come before the boundaries between nations have become less divisive than they are today. I do not believe that space flight will accomplish this miracle over night. However, the space program is certainly among the most promising and powerful agents working in this direction.

如何将食品发放给需要的人则是另外一个全新的问题，关键不在于轮船的容量，而在于国际间的合作。小国统治者对于来自大国的大量食品输入很难做出准确的判断，他们害怕伴随着食物一同而来的还有外国势力对其统治地位的影响。恐怕在国与国之间消除隔阂之前，饥饿问题无法得以高效解决了。我不认为太空计划能一夜之间创造奇迹，然而，探索宇宙有助于促使问题向着良好的方向发展。

Let me only remind you of the recent near-tragedy of Apollo 13. When the time of the crucial reentry of the astronauts approached, the Soviet Union discontinued all Russian radio transmissions in the frequency bands used by the Apollo Project in order to avoid any possible interference, and Russian ships stationed themselves in the Pacific and the Atlantic Oceans in case an emergency rescue would become necessary. Had the astronaut capsule touched down near a Russian ship, the Russians would undoubtedly have expended as much care and effort in their rescue as if Russian cosmonauts had returned from a space trip. If Russian space travelers should ever be in a similar emergency situation, Americans would do the same without any doubt.

以最近发生的阿波罗 13 号事故为例。当宇航员处于关键的大气层再入期时，为了保证通讯畅通，苏联关闭了境内与阿波罗飞船所用频带相同的所有广播通信。同时派出舰艇到太平洋和大西洋海域以备第一时间进行搜救工作。如果宇航员的救生舱降落到俄方舰船附近，俄方人员会像对待从太空返回的本国宇航员一样对他们进行救助。同样，如果俄方的宇宙飞船遇到了类似的紧急情况，美国也一定会毫不犹豫地提供援助。

Higher food production through survey and assessment from orbit, and better food distribution through improved international relations, are only two examples of how profoundly the space

program will impact life on Earth. I would like to quote two other examples: stimulation of technological development, and generation of scientific knowledge.

通过卫星进行监测与分析来提高食品产量，以及通过改善国际关系提高食品发放的效率，只是通过太空项目提高人类生活质量的两个方面。下面我想介绍另外两个重要作用：促进科学技术的发展和提高一代人的科学素养。

The requirements for high precision and for extreme reliability which must be imposed upon the components of a moon-travelling spacecraft are entirely unprecedented in the history of engineering. The development of systems which meet these severe requirements has provided us a unique opportunity to find new material and methods, to invent better technical systems, to manufacturing procedures, to lengthen the lifetimes of instruments, and even to discover new laws of nature

.登月工程需要历史上前所未有的高精度和高可靠性。面对如此严苛的要求，我们要寻找新材料，新方法；开发出更好的工程系统；用更可靠的制作流程；让仪器的工作寿命更长久；甚至需要探索全新的自然规律。

All this newly acquired technical knowledge is also available for application to Earth-bound technologies. Every year, about a thousand technical innovations generated in the space program find their ways into our Earthly technology where they lead to better kitchen appliances and farm equipment, better sewing machines and radios, better ships and airplanes, better weather forecasting and storm warning, better communications, better medical instruments, better utensils and tools for everyday life. Presumably, you will ask now why we must develop first a life support system for our moon-travelling astronauts, before we can build a remote-reading sensor system for heart patients. The answer is simple: significant progress in the solutions of technical problems is frequently made not by a direct approach, but by first setting a goal of high challenge which offers a strong motivation for innovative work, which fires the imagination and spurs men to expend their best efforts, and which acts as a catalyst by including chains of other reactions.

这些为登月发明的新技术同样可以用于地面上的工程项目。每年，都有大概一千项从太空项目中发展出来的新技术被用于日常生活中，这些技术打造出更好的厨房用具和农场设备，更好的缝纫机和收音机，更好的轮船和飞机，更精确的天气预报和风暴预警，更好的通讯设施，更好的医疗设备，乃至更好的日常小工具。你可能会问为什么先设计出宇航员登月舱的维生系统，而不是先为听力障碍患者造出有声阅读设备呢。答案很简单：解决工程问题时，重要的技术突破往往并不是按部就班直接得到的，而是来自能够激发出强大创新精神，能够燃起的想象力和坚定的行动力，以及能够整合好所有资源的充满挑战的目标。

Spaceflight without any doubt is playing exactly this role. The voyage to Mars will certainly not be a direct source of food for the hungry. However, it will lead to so many new technologies and capabilities that the spin-offs from this project alone will be worth many times the cost of its implementation.

太空旅行无可置疑地是一项充满挑战的事业。通往火星的航行并不能直接提供食物解决饥荒

问题。然而，它所带来大量的新技术和新方法可以用在火星项目之外，这将产生数倍于原始花费的收益。

Besides the need for new technologies, there is a continuing great need for new basic knowledge in the sciences if we wish to improve the conditions of human life on Earth. We need more knowledge in physics and chemistry, in biology and physiology, and very particularly in medicine to cope with all these problems which threaten man's life: hunger, disease, contamination of food and water, pollution of the environment.

若希望人类生活得越来越好，除了需要新的技术，我们还需要基础科学不断有新的进展。包括物理学和化学，生物学和生理学，特别是医学，用来照看人类的健康，应对饥饿、疾病、食物和水的污染以及环境污染等问题。

We need more young men and women who choose science as a career and we need better support for those scientists who have the talent and the determination to engage in fruitful research work. Challenging research objectives must be available, and sufficient support for research projects must be provided. Again, the space program with its wonderful opportunities to engage in truly magnificent research studies of moons and planets, of physics and astronomy, of biology and medicine is an almost ideal catalyst which induces the reaction between the motivation for scientific work, opportunities to observe exciting phenomena of nature, and material support needed to carry out the research effort.

我们需要更多的年轻人投入到科学事业中来，我们需要给予那些投身科研事业的有天分的科学家更多的帮助。随时要有富于挑战的研究项目，同时要保证对项目给予充分的资源支持。在此我要重申，太空项目是科技进步的催化剂，它为学术研究工作提供了绝佳和实践机会，包括对月球和其他行星的研究、物理学和天文学、生物学和医学科学等学科，有它，科学界源源不断出现令人激动不已研究课题，人类得以窥见宇宙无比瑰丽的景象；为了它，新技术新方法不断涌现。

Among all the activities which are directed, controlled, and funded by the American government, the space program is certainly the most visible and probably the most debated activity, although it consumes only 1.6 percent of the total national budget, and 3 per mille (less than one-third of 1 percent) of the gross national product. As a stimulant and catalyst for the development of new technologies, and for research in the basic sciences, it is unparalleled by any other activity. In this respect, we may even say that the space program is taking over a function which for three or four thousand years has been the sad prerogative of wars.

由美国政府控制并提供资金支持的所有活动中，太空项目无疑最引人瞩目也最容易引起争议，尽管其仅占全部预算的 1.6%，不到全民生产总值的千分之三。作为新技术的驱动者和催化剂，太空项目开展了多项基础科学的研究，它的地位注定不同于其他活动。从某种意义上来说，以太空项目的对社会的影响，其地位相当于 3-4 千年前的战争活动。

How much human suffering can be avoided if nations, instead of competing with their bomb-dropping fleets of airplanes and rockets, compete with their moon-travelling space ships!

This competition is full of promise for brilliant victories, but it leaves no room for the bitter fate of the vanquished, which breeds nothing but revenge and new wars.

如果国家之间不再比拼轰炸机和远程导弹，取而代之比拼月球飞船的性能，那将避免多少战乱之苦！聪慧的胜利者将满怀希望，失败者也不用饱尝痛苦，不再埋下仇恨的种子，不再带来复仇的战争。

Although our space program seems to lead us away from our Earth and out toward the moon, the sun, the planets, and the stars, I believe that none of these celestial objects will find as much attention and study by space scientists as our Earth. It will become a better Earth, not only because of all the new technological and scientific knowledge which we will apply to the betterment of life, but also because we are developing a far deeper appreciation of our Earth, of life, and of man.

尽管我们开展的太空项目研究的东西离地球很遥远，已经将人类的视野延伸至月亮、至太阳、至星球、直至那遥远的星辰，但天文学家对地球的关注，超过以上所有天外之物。太空项目带来的不仅有那些新技术所提供的生活品质的提升，随着对宇宙研究的深入，我们对地球，对生命，对人类自身的感激之情将越深。太空探索让地球更美好。

The photograph which I enclose with this letter shows a view of our Earth as seen from Apollo 8 when it orbited the moon at Christmas, 1968. Of all the many wonderful results of the space program so far, this picture may be the most important one. It opened our eyes to the fact that our Earth is a beautiful and most precious island in an unlimited void, and that there is no other place for us to live but the thin surface layer of our planet, bordered by the bleak nothingness of space. Never before did so many people recognize how limited our Earth really is, and how perilous it would be to tamper with its ecological balance. Ever since this picture was first published, voices have become louder and louder warning of the grave problems that confront man in our times: pollution, hunger, poverty, urban living, food production, water control, overpopulation. It is certainly not by accident that we begin to see the tremendous tasks waiting for us at a time when the young space age has provided us the first good look at our own planet.

随信一块寄出的这张照片，是1968年圣诞节那天阿波罗8号在环月球轨道上拍摄的地球的景象。太空项目所能带来的各种结果中，这张照片也许是最可贵的一项。它开阔了人类的视野，让我们如此直观地感受到地球是广阔无垠的宇宙中如此美丽而又珍贵的孤岛，同时让我们认识到地球是我们唯一的家园，离开地球就是荒芜阴冷的外太空。无论在此之前人们对地球的了解是多么的有限，对于破坏生态平衡的严重后果的认识是多么的不充分。在这张照片公开发表之后，面对人类目前所面临的种种严峻形势，如环境污染、饥饿、贫穷、过度城市化、粮食问题、水资源问题、人口问题等等，号召大家正视这些严重问题的呼声越来越多。人们突然表示出对自身问题的关注，不能说和目前正在进行的这些初期太空探索项目，以及它所带来的对于人类自身家园的全新视角无关。

Very fortunately though, the space age not only holds out a mirror in which we can see ourselves, it also provides us with the technologies, the challenge, the motivation, and even with the optimism to attack these tasks with confidence. What we learn in our space program, I believe, is

fully supporting what Albert Schweitzer had in mind when he said: "I am looking at the future with concern, but with good hope."

太空探索不仅仅给人类提供一面审视自己的镜子，它还能给我们带来全新的技术，全新的挑战和进取精神，以及面对严峻现实问题时依然乐观自信的心态。我相信，人类从宇宙中学到的，充分印证了 Albert Schweitzer 那句名言：“我忧心忡忡地看待未来，但仍满怀美好的希望。”

My very best wishes will always be with you, and with your children.
向您和您的孩子们致以我最真挚的敬意。

Very sincerely yours,
您诚挚的

Ernst Stuhlinger
恩斯特 史都林格

Associate Director for Science
科学副总监