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Do Developing Countries need Astronomy?

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Abstract. Astronomy can help, directly or indirectly, in the acquisition and creation of new technologies, in attracting young people to scientific careers, in providing a scientific education to the general public and in fostering international collaborations. These and other benefits of professional astronomy are critically reviewed in the context of countries which are facing urgent, basic needs. Several criteria are suggested for the best implementation of astronomy in developing countries and the most efficient collaboration with industrialized countries.

1. The Question

What is the use of astronomy? This often-asked question becomes more acute in developing countries, which are sometimes confronting many urgent problems, such as hunger, diseases, illiteracy, lack of infrastructure, etc. Is it worth investing resources and people in an endeavor that will obviously not bring immediate solutions to these and other basic needs? If astronomical research is to receive a justification, it must take into account the complex situation of developing countries. It is therefore important to make a critical assessment of the various arguments presented to support astronomy. Such is the aim of this paper.

We will summarize the main arguments in favor of pursuing astronomical research in developing countries. These can be grouped in the following categories: basic research, new technologies, scientific education, international collaboration and broader cultural aspects. Each argument will be critically assessed; possible shortcomings will be pointed out and criteria to overcome them will be suggested. research. Of course, the questions raised are also relevant to industrialized countries, where astronomy can also be considered an expensive luxury.

2. Argument No. 1: Basic Research

Astronomy deals with environments totally unlike those found in Earth-bound laboratories, where it is impossible to reproduce the range of temperatures, pressures and other physical conditions found in stars and galaxies. As such,

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astronomical research opens the way to new theoretical discoveries, which may in turn lead to practical applications, although these may come only much later. One thinks for example of positional astronomy and Newton's law and their application to space flight, or possible future uses of the energy released in the nuclear fusion, as already studied in the center of the stars.

2.1. Caveats

Policies about basic research vary. One extreme position would be to cut all funding for basic research, on the ground that it does not produce immediate economical benefits. This would be a very short-sighted view, because long-term solutions should not be neglected. In the long run a total lack of skills regarding new scientific developments would hinder a nation from mastering new technologies and competing in the global market.

The other extreme would be to invest disproportionate amounts of resources to create a project that will be the "largest of its kind", motivated by the prestige it promises, in the belief that money alone will solve the deficiencies in training and infrastructure.

2.2. Recommendations

- Wherever possible, favor *low-cost alternatives.* Frontier research can be done with small telescopes. Observational data are also available in on-line archives. Fast computing is becoming affordable. Fast and cheap communication with collaborators, as well as video conferences and access to electronic publications are now possible through the internet.

- Promote a *limited number of key projects.* These could be selected on the basis of present expertise, of local interests, etc.

- Involve *amateur astronomers.* With a minimum of professional orientation, they can contribute to serious astronomical research.

- Spread the cost of larger projects by conducting them by means of *international cooperative efforts.*

3. Argument No. 2: New Technologies

Astronomical research is often presented as a way to:

- *Acquire new technologies:* e.g., the use of databases, analysis techniques, instrument control, computing, electronics, optics, space technology, etc.

- *Acquire new skills:* The instruments should not just sit and get rusty: astronomers and students should be trained to maintain and develop new astronomical instruments.

- *Create practical applications:* although not the main goal, these are side-effects of astronomical research (spin-off), which is thus believed to galvanize indirectly technological growth through large projects.

3.1. Caveats

Nonetheless, it must be conceeded that new technologies are not necessarily good.

- *Environmental problems* are a primary concern that come to mind, but one should also be concerned with other possible disruptions.
- The social fabric may also be damaged if new technologies bring about increased social and economic *inequalities.*
- The local economy may suffer if research efforts in developing countries lead to *debts and/or economical dependence* on the industrialized nations, thus benefiting the latter at the expense of the former.
- *Health* and general human well-being may deteriorate as a consequence of new technologies.

3.2. Recommendations

- Ensure that no debt or dependency are being created and that the users of the new technologies have full training and full control.
- Ensure that there is no damage to the natural, social and human environment.

4. Argument No. 3: Scientific Education

The accumulation of capital and the attraction of investment depend less and less on the amount of a country's natural resources and labor. The key factor is the accumulation of technology based on the intensity of knowledge: science, technology and organization. Every nation needs people with good scientific training:

- to *understand* scientific discoveries made there or elsewhere
- to *apply* imported technologies
- to *fight* against pre-scientific attitudes such as astrology, reductionism in science, creationism and other prejudices
- to help leaders *make decisions* with global vision and objectivity
- to *compete* and to communicate with others on the international scene

5. Astronomy as an Attractor

Astronomy has a special appeal to a large public, probably more than any other "exact" science. Given its popularity among the general public, astronomy can make a significant contribution to meeting the above goals in light of the following:

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- Astronomy may *attract students* to scientific careers, thus providing a practical way to prepare good scientists and high-level technicians.

- Students in astronomy and space sciences acquire *valuable skills* of observation, analysis of data, use of scientific reasoning, writing, publication, etc.

- Such students can find work in *related fields*, including computer science, remote sensing, meteorology, communications, etc.

- Again, *amateur astronomers* should be considered and be given the opportunity to acquire these skills, for example through continuous education.

5.1. Caveats

- While trying to emulate the education level of industrialized countries, one must be careful not to create another dependence, a sort of *inferiority complex* that would set in the minds of students the impossibility of attaining the (perceived) level of other countries.

- A related problem is the *brain drain* (emigration of the best-trained people). Several reasons could explain this drain:
  – low salaries in developing countries
  – lack of good research conditions, such as telescopes, computers, libraries
  – the above-mentioned "inferiority complex" (doubts about the feasibility of frontier research in one's own country)
  – the lack of willingness to work toward strengthening astronomy research in the home country

5.2. Recommendations

- Perhaps the most important answer to these issues is the fostering of a *positive attitude* towards one's own country, both a realistic trust in its potential and a solid personal commitment to realize this potential. These should be the basic bricks of any educational program.

- As noted earlier, frontier research can be done with limited budgets, through the *creative use* of limited resources.

- Students from developing countries should be taught that helping to establish high-level astronomy at home can be as worthy a contribution to astronomy as doing pure research. During their studies, they must be encouraged to participate in the *development of local facilities.*

- Also, *expatriate researchers* have many opportunities to help their home country: remotely collaborating with astronomers from home, giving lectures during occasional visits home, supervising dissertations of students from their home country, inviting them to spend working visits at their institution, etc.

6. Argument No. 4: International collaboration

More than before, our world needs cross-cultural integration. Astronomy provides one of the most convincing *examples of collaboration between countries*:

- with peaceful goals
- without exploiting the poorer partner
- with coauthors frequently from different countries
- with free dissemination of discoveries, information, software (IRAF MIDAS), expertise (no one is surprised if the advisory panel for a new large telescope is made of the directors of the competing telescopes), etc.

Why is this so easy in astronomical circles? Probably because there is no direct economical benefit at stake.

It should also be noted that developing countries have *much to offer* to the larger astronomical community:

- their climate
- their territorial extension (e.g. more solar eclipses happen in developing countries than in rich countries)
- equatorial locations (e.g. for stationary satellites)
- access to southern-hemisphere objects (e.g. Chile)
- access to locations needed for all-Earth telescopes, large-baseline interferometry, etc.
- and finally, alternative views on old questions, based on different cultural backgrounds.

6.1. Caveats

- Collaboration should not merely use foreign land (cf. the case of Chile) but should also *benefit the host country* (astronomy research, technological spin-off, etc).
- Collaboration should help reinforce the *research groups* of local astronomers (cf. UN Workshops on Basic Science).
- Collaboration should allocate means for *teaching and outreach.*

The above also applies to the collaboration *between* developing countries (beyond national and regional rivalries).

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6.2. Recommendations:

- International collaborations should seek to benefit the poorer partner.
- The benefits of the collaboration should not only be the installation of an astronomical instrument, but all that is necessary to build strong research groups: computing facilities, libraries, teaching programs, international interaction, etc.
- The collaboration should be concerned not only about initiating programs but also about the long-term growth of astronomical research in developing countries.

7. Argument No. 5: Cultural Impact

Is it enough to try to improve the economical sphere ("what we have") without taking care of *what we are*? This second sphere could be called "culture". What is meant here is our view of ourselves, our motivation for growth as individuals and as a society.

Could astronomy contribute to enrich humankind in that sense? in unexpected cultural and epistemological ways?

- Astronomy has deep roots in virtually every human culture. It has played a significant role in many civilizations of the past (e.g. Maya, Inca). Today it still holds a fascination for many people, as seen for example in the interest in eclipses and in the exploration of the solar system.
- Having no direct applicability, astronomy is well-placed to stimulate reflexions beyond the immediate.
- Astronomy explores the limits of physical reality and raises questions regarding:
  - the origin of the Earth and of the universe
  - our place in the cosmos and our destiny
  - our uniqueness in the universe.
- Astronomy discovers a universe that is always surprising, thus helping to transcend old views and find new solutions to old problems.
- Astronomy presents a universe extremely vast and complex; thus it helps put reality into perspective and encourages us to look for global, long-term solutions. Yet the majority of people remain unaware of the size of the universe, of the place of the Earth, of the distance to the stars and may even believe in astrology.

Astronomy is unique in that it addresses human questions from the standpoint of an exact science. Hence:

- It helps to formulate these questions.
- It helps to provide scientific evidence to confront theories about the origins, extension and evolution of our universe.
- It helps to integrate science into human concerns.

7.1. Recommendations:

- Promote the dialogue between exact sciences and thinking in the humanities.
- Astronomers must avoid the "guru" role: the road to the truth is a long and arduous one.

8. Conclusions

In this paper we have tried to show that many of the arguments usually put forward to justify astronomical research have a real value. Astronomy can contribute to the growth of developing countries. However the value of astronomy could be offset if attention is not paid to the way it is implemented as basic research, technology development, education, international cooperation and reflection on ultimate human questions. Therefore a thorough analysis of its implementation is necessary to ensure that it contributes to the intended goals we have set forth in the benefit of the society and individuals. It is hoped that the sketchy lines of thought presented here may foster further reflection and discussion of these important questions, in order to search for improved policies.

1. Astronomy can bring many benefits to developing countries, well beyond the scope of pure research:
   - technological spin-off
   - scientific training
   - international collaboration
   - changes to culture
2. However, criteria should be applied to ensure that the benefits offset the possible damages to the host country.
3. These criteria could be grouped under the following headings:
   - do not create dependency
   - respect the cultural identity of the host country
   - make provision for growth of local astronomy
   - educate the public
   - involve amateurs.

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