How Astronomers Perceive the Societal Impact of Research: An Exploratory Study

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Keywords
Societal impact, societal relevance, societal return

We present an exploratory study of the perception of professional astronomers about the societal impact of astronomy. Ten semi-structured interviews with astronomers from a range of career and cultural backgrounds have been conducted to gain in-depth insight into their opinion about societal impact and their approach in realising it. The results show that the interviewees are aware of the diversity of impacts that astronomical research has. However, they are mostly active in outreach and only a few activities are incorporated into their jobs to achieve an impact on development. There is little contact with stakeholders in industry, policy or other fields, like development. Besides, a structured approach in their personal outreach is lacking, and assessment is only done informally. Despite the limited sample size of this study, the results indicate that a further change is necessary to engage professional astronomers with topics of development and societal impact to create action on the level of individual researchers.

Introduction

In most research institutes, there are three main aims: research, teaching and public engagement. However, the latter is often neglected, although in the past years there has been a growing emphasis on the societal impact of science. The societal impact of science can be understood as science that includes societal benefit and affects societal challenges (Bornmann, 2013). It entails social, cultural, environmental, and economic returns and engages societal actors, such as policymakers, industry, and end users.

Astronomy impacts societies in different ways by producing certified knowledge; training skilled workers; driving innovation by pushing technical limits; contributing to collective goods, like prestige of a country and environmental awareness; and by inspiring people (Davoust, 1995). Serendipity is extremely important in astronomical discoveries (Fabian, 2010), and societal applications of science are often arrived at non-linearly (Schneider, 2007). More spin-offs might even come from fundamental than applied research (Llewellyn Smith, 2008). Rosenberg et al. (2014) gathered a wealth of examples of applications originating in astronomy, from X-ray luggage belts to hospital cleanrooms. However, they conclude that maybe the most important consequence of astronomy is that it highlights our place in the universe and promotes global citizenship. Astronomy can also contribute to socioeconomic development (McBride, 2018).

Background

The process of creating societal impact can be captured in a four-step process (Meijer, 2012). Firstly, the societal objectives are defined, and subsequently the stakeholders and activities to connect with them. Next, the impact must be measured with indicators, and finally, the results are reflected by scoring each indicator to adjust the objectives if necessary.

Outreach efforts of physicists and biologists mostly concern presentations for children and activities for a general audience, like public lectures (Ecklund, 2012). Perceived impediments to outreach activities include the “Sagan effect” (Hartz & Chappell, 1997), where individuals who do outreach are thought to do less rigorous research by peers. Besides, researchers believe the public is disinterested in science and there is doubt whether scientists or an intermediary should be responsible for outreach. Finally, institutes prioritise research and there is often little time to engage in outreach as well as a lack of reward for it (Ecklund).

Most astronomers have a positive attitude towards education and outreach, although they spend less time on it than recommended (Dang & Russo, 2015). Personal motivations are the main drive to interact with the public but there is little institutional support (Sarperi, 2018), with seniority being another important factor (Entradas & Bauer, 2018).

Research Question

The main goal of this article was to explore what professional astronomers perceive to be the societal impact of astronomy and whether they incorporate it into their work. Previous research has been conducted on how astronomers engage with the public, as well as their motivations for it (see Ecklund; Dang & Russo; Sarperi; Entradas & Bauer; and Bastow, 2014). However, there is little research on astronomers’ concern about the wider impact of their work on society and if there is a systematic approach.

We presume that there is a discrepancy in the attitude of astronomers: They might believe that societal impact is important, but not incorporate it into their work. We expected the main method used to affect society are traditional outreach activities without defining a broader strategy.

Many factors might play a role in how any astronomer regards societal impact (e.g. seniority, field of expertise, socio-ographical-cultural demographics). To mitigate the influence of these factors, the
Societal Impact Efforts

All the interviewees engage in outreach activities that they feel contribute to society and some (N=5) feel that it is their duty to do so. Besides sharing discoveries in media, many participants give public talks. However, they agree that their own research generally does not have a real impact on society (N=9).

Despite the active role taken by the participants, some (N=3) question who is responsible, researchers or an intermediary, for achieving impact. Furthermore, one interviewee thinks societal impact should not always be the main goal of research and that “there has to be room for things that are just interesting, impact does not need to drive it.”

All participants agree that societal impact is emphasised nowadays and it cannot be ignored. Seven of them know that their institutes include it in their mission. However, the answers to whether public engagement activities are appreciated are conflicted. The participants indicate that engaging in activities related to societal impact is generally appreciated by colleagues, although there is not always respect for it.

Table 1. Characteristics of the participant sample.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Nationality</th>
<th>Based in</th>
<th>Academic position</th>
<th>Field</th>
</tr>
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<tbody>
<tr>
<td>F</td>
<td>67</td>
<td>UK</td>
<td>South Africa</td>
<td>Professor</td>
<td>Variability stars</td>
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<tr>
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<td>Lebanon</td>
<td>Assistant Professor</td>
<td>Mercury exosphere, comets</td>
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<tr>
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<td>Russia</td>
<td>USA</td>
<td>Assistant Professor</td>
<td>Computational/theoretical astrophysicist</td>
</tr>
<tr>
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<td>Postdoc</td>
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<td>Professor</td>
<td>Galaxy evolution, stellar populations of galaxies, instrumentation</td>
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<td>(PhD) Director of corporate strategy</td>
<td>(Pola Aurora) Policy and strategy</td>
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<td>Australia</td>
<td>The Netherlands</td>
<td>PhD Student</td>
<td>Galaxy formation and evolution</td>
</tr>
</tbody>
</table>

Societal Impact Efforts

The interviews were recorded after informed consent from the participant. A list of questions formed the framework of the interview and care was taken to formulate questions in an open and non-lead-
The sample expresses mixed opinions on whether the professional astronomy community wants to actively pursue societal impact. One participant believes that many astronomers like to do outreach, while another thinks that most are "worried about bugs in their code, rather than talking to the public". If given the opportunity to do public engagement most would do it, but they would not seek it out.

**Barriers and Improvements**

Generally, the participants realise that creating societal impact with fundamental science is an unpredictable process (N=6) as "it’s hard to know what the impact will be of what you’re studying". They mostly feel like they can spend time on societally-relevant activities within their job (N=6).

Participants indicate that a lack of funding is an obstacle to achieving societal impact (N=4), as well as the high workload of their job (N=3) and language (N=2). One interviewee mentions the competition between universities as an obstruction.

The main reported improvement is the inclusion of minorities and diversity (N=5). Some participants (N=4) mention the accessibility of astronomy ("Science needs to feel familiar to people."). and only one participant has concerns about potential negative impact and emphasises the need for two-way communication ("Try to have a dialogue with them, not just explain."). Assessment of societally-impactful activities that the participants engage in is often only done informally and without structure (N=7).

**Conclusion**

The professional astronomers in this study are aware of the different ways astronomy can impact positively on society. They deem societal impact important and are motivated to communicate with the general public, mainly through talks and classroom activities, and feel like they have time for doing so. Beyond the general public, they have few connections with industry or policymakers. Self-reported barriers in achieving societal impact include high workload, priority on research tasks, lack of funds and language barriers. Besides, they realise that societal impact is difficult to measure due to the serendipitous nature of discoveries in astronomy (Ecklund, 2012). According to the participants, astronomers could improve on achieving impact by making research more accessible and being more inclusive with underrepresented groups.

Even though no rigorous conclusions can be drawn based on the limited sample size, the results indicate that professional astronomers might not incorporate adequate activities into their job to achieve societal impact. Training astronomers to adopt a backwards approach, where the desired societal impacts of an activity are defined first, could be part of the solution.

**References**


### Category | Impact | N = x
--- | --- | ---
Technology transfer | Spin-offs | 10
 | Big data | 5
Economic benefits | Acquired skills | 7
 | Astrotourism | 5
 | Job creation | 2
Education | Attract children to science | 8
 | Critical thinking | 7
 | Counteract misinformation | 6
 | Human capital | 5
Knowledge creation | Inspire | 10
 | Understanding the world | 7
 | Societal Advancement | 2
Cultural | Perspective | 6
 | Inclusiveness and diversity | 5
 | Global citizenship | 3
 | Appreciation of Earth | 3
Diplomacy | International collaboration | 4
 | Decision-making | 3
 | Research infrastructures | 2

**Table 2.** Overview of the types of impacts of astronomy on society mentioned by the interviewees, per category. The right column shows the number of interviewees out of the sample of 10 that mentioned each impact.


Meijer, I., ‘Societal returns of scientific research—How can we measure it?’, Centre for Science and Technology Studies, Leiden University, 2012, CWTS-WP-2012-014


Sarperi, S., J. Cramer, and P. Russo, ‘Wat moet ik met het publiek?’, Nederlands tijdschrift voor Natuurkunde, April 2018


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**Biography**

Michelle Willebrands is the project manager of the International Astronomical Union’s (IAU) European Regional Office of Astronomy for Development (E-ROAD) at Leiden Observatory. She is the lead on the Advocacy and Legacy work package of the H2020 spaceEU project.

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