The decline of astronomical research in Venezuela

During the last 15 years the number of astronomy-related papers published by scientists in Venezuela has been continuously decreasing, mainly due to emigration. If rapid corrective actions are not implemented, professional astronomy in Venezuela could disappear.

Néstor Sánchez

Although its first steps date back to the nineteenth century, it can be said that modern astronomy in Venezuela started in the 1970s with the construction of the National Astronomical Observatory and the foundation of the Centro de Investigaciones de Astronomía (CIDA), created to manage the Observatory. During the 1980s, Venezuela strengthened and consolidated this research field until it became a very competitive country in Latin America, behind only the four countries in the region with the longest astronomical tradition: Argentina, Brazil, Chile and Mexico.

Since 1999 Venezuela has undergone a transformation process, the ‘socialism of the twenty-first century’, led by the state. In a deeply polarized country, a considerable debate remains between supporters and detractors of the Venezuelan government about whether the change has been for the better or for the worse. Science and technology have been part of this process and, obviously, have also suffered from such a polarization. While some authors consider the Venezuelan government to be backing science and maintain that, despite the political crisis, the total investment has been continuously increasing, other researchers claim that budget cuts, the discretionary use of resources (on the basis of political loyalty) and the general economic, political and social crisis are seriously damaging scientific research in Venezuela. Apart from the existing polarization, the economic crisis makes things difficult. Almost all research funding comes from the state but most of that budget goes into paying salaries, leaving only a small percentage for infrastructure, graduate or postgraduate programmes and research projects. Payments are made in local currency (bolívar), which suffers from high inflation, and there is an exchange control system that prevents unauthorized (by the Venezuelan government) access to foreign currency. All this makes it difficult for researchers and institutions to buy needed resources (materials, equipment, books and journals) or to participate in international events, and, additionally, makes Venezuela unattractive as a destination for foreign researchers or for student mobility.

An apparently undeniable reality is that, whatever the underlying reasons, Venezuelan scientists (defined here as scientists based in Venezuela and working for a Venezuelan institution, irrespective of their nationality) are emigrating at accelerated rates and, as a consequence, scientific production (published papers) has been decreasing over recent years. The brain-drain seems to be similar in magnitude for all fields of knowledge and for Venezuelan astronomy in particular has meant a setback of about 20 years.

Table 1 | Main characteristics of astronomy/astrophysics research in Venezuela (1980–2019)

| Main research networks                      |  |
|---------------------------------------------|---|
| Stellar, Galactic and extra-Galactic astronomy | 37.3% |
| Relativistic astrophysics (and theoretical physics) | 31.1% |
| Atomic physics                              | 7.4% |
| Fluid mechanics                             | 6.3% |

| Main journals                             |  |
|-------------------------------------------|---|
| The Astrophysical Journal                 | 25.2% |
| Physical Review D                         | 10.3% |
| Astronomy and Astrophysics                | 8.8% |
| Monthly Notices of the Royal Astronomical Society | 8.0% |
| Astrophysics and Space Science            | 5.9% |
| Classical and Quantum Gravity             | 5.5% |
| General Relativity and Gravitation        | 4.8% |
| The Astronomical Journal                 | 4.1% |

| Main research centres                     |  |
|-------------------------------------------|---|
| Centro de Investigaciones de Astronomía (CIDA) | 29.9% |
| Universidad de Los Andes (ULA)            | 22.2% |
| Universidad Central de Venezuela (UCV)     | 16.3% |
| Universidad Simón Bolívar (USB)            | 13.7% |
| Instituto Venezolano de Investigaciones Científicas (IVIC) | 11.2% |

40 years of astronomy in Venezuela

According to the NASA Astrophysics Data System (ADS), between 1980 and 2019 inclusive, a total of 798 refereed papers in the astronomy collection (excluding proceedings and book chapters) were published with at least one author affiliated to a Venezuelan institution. Table 1 summarizes the main characteristics derived from these publications.

By examining these publications and using other ADS tools, it is possible to identify four main research networks, that is, groups of authors sharing papers and/
or lines of research. The most sizeable network is related to what we could call ‘traditional’ astronomy, with the bulk of papers dealing with stellar astronomy (including young stars and variable stars), Galactic astronomy (including stellar clusters) and extra-Galactic astronomy. This research was published in standard astronomical journals (particularly in The Astrophysical Journal) and was carried out at CIDA (mostly) and ULA. There is a second important but completely different network whose major research line is relativistic astrophysics (relativistic fluids), though this network also includes several authors working in different areas of theoretical physics and publishing in different journals, especially Physical Review D. Authors in this network belong to the following institutions (in order of contributions): UCV, ULA, USB and IVIC. These two main networks account for almost 70% of the total astronomy research in Venezuela in the last 40 years. There are, however, two smaller but very well-defined research networks: one relates to atomic tools), I searched for the main Venezuelan astronomers/astrophysicists. By ‘main’ I mean authors who published at least ten papers in the period 1980–2019 or, if not fulfilling this condition, those who have an average publication rate ≥0.5 papers per year. I extracted the list of main authors and also their institutions and activity time intervals (years of the first and last papers published with an affiliation to a Venezuelan institution). I identified 30 main authors, of which 73% worked at CIDA (14 authors) or ULA (8) and the remaining ones were affiliated with other centres (IVIC, UCV or USB). This group of main authors have been involved in ~65% of the papers published during the last 40 years. The number of years of an author’s activity ranges from eight to 40 (still working in Venezuela), following a roughly flat distribution. Their mean publication rates range from 0.5 to 3.5 papers per year, with 47% of the authors publishing more than one paper per year and only 13% more than two papers per year on average.

Once I identified these main authors, I used the ADS to verify whether, after their last active year, they have or have not continued publishing with an affiliation in a different country. Since 2007, 12 of the main authors have emigrated to other countries (Chile, Colombia, Mexico, Spain and the United States), five have stopped publishing at all (retirement or unknown reasons) and two have passed away. There are still 11 active researchers in Venezuela, though some of them are currently living abroad. The number of active authors per year is plotted as the red line in Fig. 1. The emigration process started in 2007 but the number of new main authors increased until 2008, so the net number of active researchers started decreasing in 2009–2010. The number of active authors in 2019 is only 38% of the historical peak value in 2009. A remarkable fact is that there have been no new main astronomers in Venezuela since 2008, based on the mentioned criteria of having an average production rate higher than 0.5 astronomy-related refereed papers per year.

What has been the real impact of the emigration of Venezuelan astronomers? Knowing the mean production rates and emigration years for each of the 12 emigrated authors, the total mean production rate can be corrected by emigration (the dark blue line in Fig. 1). Despite the yearly variations, the corrected number of papers per year remains nearly constant over the last ten years at around 33.1 papers per year, a value very close to the historical maximum.

Venezuelan astronomy is falling behind
A direct comparison with other Latin American countries clearly illustrates the gradual decline of the levels of scientific research in Venezuela. Figure 2 shows the number of papers in physics and astronomy for some selected countries (excluding the top four countries in astronomy research in Latin America). The data was retrieved from SCImago Journal & Country Rank. Venezuela is the only country that has inverted the general growing trend and Colombia, Ecuador, Peru and Uruguay have already surpassed Venezuela in number of...
papers per year. Particularly noteworthy is the case of Colombian astronomy, for which a clear slope change can be seen indicating that it has been positioned fifth in the region since 2005.

In terms of production rate (papers per year), Venezuelan astronomy is at present equivalent to ~20 years ago. The number of papers depends almost exclusively on the number of researchers. So, the true problem of Venezuelan astronomy is not production but the fact that Venezuelan scientists are emigrating, and this emigration is far from over. According to data from the World Bank, the total population in Venezuela started to decrease for the first time in its history, from a historical maximum of ~30 million inhabitants in 2015 to ~28.9 million in 2018. And the main reason for this drop is the net migration flow because, even though the birth rate has been decreasing for several decades, it is still higher than the (currently increasing) death rate. The International Organization for Migration estimates that in 2017 the number of Venezuelans living abroad was 1.6 million. Astronomy is a particularly fragile community in Venezuela because of the relatively low number of senior researchers. A simple linear extrapolation (by eye) suggests that Venezuelan astronomy could even disappear entirely in a few more decades.

Can this trend be reversed? Certainly not in the short term. Venezuelan scientists are not leaving their country because of difficulties in their scientific activities, but rather because of serious difficulties in their day-to-day lives. Their salaries seem ridiculous in a country with a hyperinflation rate of several hundred percent a year (~130,000% in 2018 to ‘only’ ~9,600% in 2019). In any case, money is relatively useless due to a serious scarcity of food, medicines and other basic goods. Violence is also a contributing factor, Venezuela being one of the most dangerous countries in the world.

The non-governmental organization known as the Venezuelan Violence Observatory estimated that in 2019 about 16,500 people were killed (homicides committed by criminals, caused by ‘resistance to authority’ or violent deaths of undetermined intent), placing Venezuela as the country with the highest per capita murder rate in Latin America. In this scenario, defining new science policies and/or substantially increasing the assigned budget in order to improve infrastructure or graduate and research programmes is not enough to reverse the situation. Deeper changes must be undertaken to address the underlying causes.

Néstor Sánchez
Universidad Internacional de Valencia (VIU), Valencia, Spain.
e-mail: nestor.sanchez@campusviu.es

Published online: 10 August 2020
https://doi.org/10.1038/s41550-020-1175-3

References
1. Martínez Picar, A. & Salas Ramírez, H. In Proc. 25th International Meteor Conference 24–32 (IMC, 2007).
2. Hearnshaw, J. in IAU Special Session 5 (eds Hearnshaw, J. & Martínez, P.) 9–20 (2007).
3. Ribiero, V. A. R. M., Russo, P. & Cárdenas-Avendaño, A. Astron. J. 146, 138 (2013).
4. Morales, A. J., Borondo, J., Losada, J. C. & Benito, R. M. Chaos 25, 033114 (2015).
5. Cabrera, J. L., Guerrero, L. E. & Donoso, A. Nature 421, 786 (2003).
6. Barreto, G. R. Science 325, 536 (2009).
7. Chacón-Escamilla, J. Science 325, 537 (2009).
8. Mendoza, C. & Urbina, J. A. Nature 421, 473 (2003).
9. Requena, J. Nature 422, 257 (2003).
10. Bilbao, C. Science 324, 1514 (2009).
11. Pravec, P. Nature 535, 336–337 (2016).
12. Requena, J. Nature 536, 396 (2016).
13. Requena, J. & Caputo, C. Interciencia 41, 444–453 (2016).
14. Paniz-Mondolfi, A. E. & Rodríguez-Morales, A. J. Science 346, 559 (2014).
15. Kurtz, M. J. et al. Astron. Astrophys. Suppl. Ser. 143, 41–59 (2000).
16. Higuraga, M. A. Rev. Mex. Astron. Astrofís. 49, 3–6 (2017).
17. Ait, H. A. In 209th Meeting of the American Astronomical Society abstr. 108.03 (AAS, AAPT, 2006).

Competing interests
The authors declare no competing interests.