

# The rise of Astrotourism in Brazilian parks. I

## The Três Picos state park in Rio de Janeiro

Daniel R. C. Mello<sup>1</sup>, Igor Borgo<sup>1</sup>, Fabíola A. B. Gomes<sup>2</sup>, Ricardo G. César<sup>3</sup>, & Ester de Pontes Silva<sup>4</sup>

<sup>1</sup> Universidade Federal do Rio de Janeiro, Observatório do Valongo; e-mail: mello@ov.ufrj.br

<sup>2</sup> Agência Astrotrilhas, Rio de Janeiro

<sup>3</sup> Universidade Federal do Rio de Janeiro, Instituto de Geociências

<sup>4</sup> Universidade Federal Rural do Rio de Janeiro, Departamento de Administração e Turismo

**Abstract.** Since the last decade, an innovative tourism segment has emerged around the world, although it is almost unknown in Brazil. Named astrotourism or astronomy tourism, its actions aim to use suitable tourist destinations for stargazing. Astrotourism combine tourist practices with environmental awareness by discussing the impacts of light pollution and also intend to propose an experience tourism, contributing to the dissemination of knowledge, the non-formal science education and innovative approaches in scientific communication. Moreover, its range of possibilities can contribute to community-based tourism and also for local economy diversification. Among the suitable places for astrotourism development, Nature Conservation Units (in Brazil, Unidades de Conservação da Natureza - UC) stand out. The creation of Dark Sky Parks or Dark Sky Reserves around the world has been driving the sector and has awakened, in people, the attract of the starry sky and the urgency of its preservation. Brazil has an unequivocal potential to explore astrotourism with the parks being the most promising locations. Our work, starting with the creation of Astrotourism in Brazilian Parks project intends to conduct a study with an unprecedented methodology, using the Rio de Janeiro State Parks in the first instance. Our methodology consists of carrying out fieldwork with the aim to characterizing the night sky quality from light pollution quantification using Sky Quality Meter (SQM), analyzing the environmental, climatological and structural conditions, available tourist facilities, and exploring astrophotography of the night sky in parks. We present here the first results from this proposal, based on the analysis performed at the Três Picos State Park (Parque Estadual dos Três Picos - PETP). Being the largest UC in Rio de Janeiro state, we discuss, based on our results, how PETP is also a promising location to astrotourism.

**Resumo.** A partir da última década, um segmento turístico inovador tem surgido em diversos países do mundo, embora seja quase desconhecido no Brasil. Com a denominação de astroturismo ou turismo astronômico, suas ações pretendem utilizar destinos turísticos adequados para a observação dos astros. O Astroturismo propõe práticas turísticas com conscientização ambiental ao discutir os impactos da poluição luminosa e, também, um turismo de experiência, contribuindo para a difusão do conhecimento, para as ações de cunho educacional e inovadoras de divulgação científica. Além disso, seu leque de possibilidades pode contribuir para o turismo de base comunitária e para a diversificação da economia local. Entre os locais adequados para o astroturismo, destacam-se as Unidades de Conservação da natureza (UCs). A criação das reservas ou parques de céu escuro (Dark Sky Parks) ao redor do mundo vem impulsionando têm despertado novamente, nas pessoas, o encanto do céu estrelado e a importância de sua preservação. O Brasil possui potencial inequívoco para explorar o astroturismo, sendo os parques, os locais mais promissores. Nosso trabalho, a partir da criação do projeto Astroturismo nos Parques Brasileiros pretende de forma inédita realizar um amplo estudo utilizando inicialmente os parques do estado do Rio de Janeiro. Nossa metodologia consiste na realização de trabalho de campo com objetivo de caracterizar a qualidade do céu noturno a partir da medição da poluição luminosa com o uso do Sky Quality Meter (SQM), analisar as condições ambientais, estruturais, os equipamentos turísticos disponíveis e obter registros fotográficos do céu noturno. Neste trabalho, apresentamos os primeiros resultados advindos desta proposta, a partir da análise realizada no Parque Estadual dos Três Picos (PETP), localizado na região serrana do estado. Como maior UC fluminense, discutimos, a partir de nossos resultados, como o PETP se insere também como local promissor para atividades do astroturismo.

**Keywords.** Astrotourism – Science Communication – Light Pollution

### 1. Introduction

Astrotourism is a relatively recent segment of integrated activities focused on ecotourism, geotourism, experience tourism and scientific tourism, which uses suitable tourist destinations for stargazing Stimac 2019. These activities can take place in dark locations away from city lights (dark sky astrotourism) or from astronomical observatories, planetariums and science museums focusing on astronomy, even in urban centers Alcázar 2017. By discussing the implications of light pollution beyond the astronomical context, astrotourism also promotes itself a tourism of deep concern with environmental issues. The risk of losing the starry sky has put the preservation of dark places in a special situation, attracting tourists to places of nature connection and also the bright of the Milky Way. Find these places has been one of the objectives of this new shape of tourism, which has attracted

the attention of people all over the world Fayos-Solá et al. 2014. Among the places around the world where these activities are prominent we cite dark sky reserves or dark sky parks, generally known as Dark Sky Places (DSPs). They can be placed as patterns regarding to environmental preservation, research and constant monitoring of light pollution, policing of nighttime activities, and suitable design for astrotourism Collison & Poe 2013. Currently, there is almost three hundred certified Dark Sky Places around the world IUCN 2009, most of them in Europe and the United States of America. The success of astrotourism in many countries is closely related to DSPs, and encouraging creation of parks, reserves or dark sky communities is of utmost relevant to expand this success.

Many countries have started to invest in Astrotourism in the last two decades including Spain, USA and Chile. They are ex-

amples of places which astrotourism is already consolidated. In Brazil, astrotourism is still a scarce explored activity although it has started to emerge in the last two years even modestly. However, there is a undoubtedly potential for this new tourism segment lying dormant yet in the hundreds of national and state parks all Brazilian regions Mello et al. 2022b. Studying and evaluating this potential using a consistent methodology is the first and important step to encourage and promote this new tourism niche. The recent creation of first dark sky park in the country, The Desengano State Park (Parque Estadual do Desengano - PED) in the state of Rio de Janeiro Marins et al. 2022 corroborate the Brazilian potential to explore astrotourism. Our intention with this work is show the astrotourism, discuss its introduction as a new tourist activity in national territory and study the potential of the Rio de Janeiro state parks (first step) from the analysis of night sky quality with the evaluation of the light pollution impact, climatological end environmental conditions, tourist facilities available for the parks and exploring astrophotography of the starry night parks.

In this topic we introduce the astrotourism and discuss the value of starry sky and its link to environmental preservation through the light pollution, anchored to dark sky places and intergovernmental initiatives to preserve dark skies. In the second part we present our proposal, based on the astrotourism in Brazilian Parks Project, pioneer on a national scale to establish researching in parks and promote astrotourism, the science communication and environmental education using Astronomy. In the same topic, we also present the methodology used for the studies. In the fourth topic we show the first results of the proposal from a study carried out in the Três Picos State Park (Parque Estadual dos Três Picos - PEP) as well as a discussion itself in the fifth topic.

### 1.1. Dark Sky Places

Dark sky parks and reserves have established themselves as the most suitable locations for astrotourism. Besides playing a fundamental role in maintaining the Earth biodiversity, these reserves and parks also value the keeping of the starry sky, collaborating to mitigate the light pollution. They have been supported by several relevant dark sky preservation institutions such as the International Astronomical Union (IAU), the World Tourism Organization (UNWTO), the International Union for the Conservation of Nature (IUCN), the International Dark Sky Association (IDA), and the Starlight Foundation (FS). Both IDA and FS list in their service of certifications, hundreds of parks and reserves around the world that receive considerable visitors to astrotourism. Among the criteria for certification of DSPs we list (i) dark sky conditions, established by the criteria of celestial objects visibility, sky transparency and low rainfall rates throughout the year. In general, the degree of sky darkness can be defined from the Bortle Scale Bortle 2001 and the sky luminance quantification by means of Sky Quality Meter (SQM) measurements; (ii) regulate and provide suitable structural conditions for night tourist or visitor receptions to practice the amateur or professional astronomical observations; (iii) establish a commitment to the appreciation and preservation of cultural and historical local aspects, including park and reserve; and (iv) support environmental practices, initiatives and contributing to the conservation, biodiversity preservation and the sustainable use of water and mineral resources IDA 2018. Currently, the world list counts almost three hundred dark sky preservation sites, among parks, reserves, sanctuaries, communities and tourist destinations IUCN 2009.

## 2. Astrotourism in Brazilian Parks Project

In order to boost the astrotourism and science communication in an immersive experience through intimate contact with nature, the research project Astrotourism in Brazilian Parks<sup>1</sup> was created in early 2021. With the support of the Instituto Estadual do Ambiente (Inea) and Secretaria de Ambiente e Sustentabilidade (Seas-RJ) of Rio de Janeiro state and the Instituto Chico Mendes para a Conservação da Biodiversidade (ICMBio), the project holds researches from the Observatório do Valongo (OV) and Instituto de Geociências (IGeo) of Universidade Federal do Rio de Janeiro (UFRJ), Departamento de Administração e Turismo de Universidade Federal Rural do Rio de Janeiro (UFRRJ) and Astrotrilhas those have joined efforts to evaluate the potential of natural parks in the state of Rio de Janeiro to astrotourism development Mello et al. 2022a.

### 2.1. Methodology

The characterization of a promising site for astrotourism comprises through several stages, including the potential for visitation according to the supply and tourist facilities, free access and means of transportation, qualified professionals, reasonable weather and climatological conditions throughout the year that allow clear and starry nights, and especially dark sky conditions powered by low levels of light pollution. This proposal seeks to characterize some of these peculiarities based on fieldwork carried out in the Rio de Janeiro natural parks.

#### 2.1.1. Light pollution quantification

Although one can use light pollution maps produced from satellite databases such as the World Atlas of Night Sky Brightness Falchi et al. 2016, we have chosen quantify the sky quality by measuring *in situ* night sky brightness. This methodology allows working with data independently and measuring the sky quality at the time interval periods required to work objectives. For this large-scale project to characterize the night sky of the parks, we use the Sky Quality Meter (SQM) photometer, an especially sensitive instrument for radiation detection, which measures the amount of light emitted by the sky, which allows to quantify the light pollution. The SQM is the most widely used tool in the world for this purpose, commonly used by professionals and amateurs astronomers for measurements and assessments of astronomical sites Sánchez de Miguel et al. 2017. We used the SQM-L version, a portable instrument, equipped with a lens that better directs the studied sky area, allowing precise measurements within a range (full width) of 20°. This instrument is calibrated to be sensitive only to visible radiation, covering a magnitude range of 16 to 22  $\text{mag}/\text{arcsec}^2$ . In this range, a value of 16  $\text{mag}/\text{arcsec}^2$  magnitude indicates a saturated light pollution sky (urban areas), while a measurement of 22  $\text{mag}/\text{arcsec}^2$  magnitude indicates a pristine night sky, without the effect of artificial illumination. For our analyses, we opted SQM to quantifying sky brightness at celestial sphere different positions in addition to the measurements at zenith, commonly performed. For our analyses, the SQM-L was mounted on a fixed tripod, free to be oriented at different points of the sky (height and azimuth) in order to cover all the desired measurements. Although our methodology is being similar to the analysis made by Zamorano et al. 2014, performed for night sky quantification in Spanish astronomical sites, we used distinct numerical methods to interpolate the point data.

<sup>1</sup> contact the project with email [parquesastronomia@gmail.com](mailto:parquesastronomia@gmail.com) and in instagram profile [@astroturismoparquesbr](https://www.instagram.com/astroturismoparquesbr).

For each location chosen for light pollution determinations, we record 49 celestial sphere points, which are later plotted using the software Origin PRO to generate the light pollution maps.

### 2.1.2. Climatological evaluation

In addition to the appropriate sky conditions provided by low light pollution levels, an acceptable location for astrotourism should allow the best possible use of the nights throughout the year so far. Indeed, the evaluation procedure of these locations also involves the climate condition models and weather forecast monitoring, based on the crucial meteorological variables analysis, such as cloud cover rates, daily temperatures and average annual precipitation index. For our analysis, we make use of the data available by the Instituto Nacional de Meteorologia - INMET.

### 2.1.3. Tourist Facilities

In order to identify the presence of tourist facilities such as accommodation services, hotels, restaurants, coffee shops, food bars and beverage services around the parks where located, a survey was conducted using the Cadastur (Cadastro dos Prestadores de Serviços Turísticos do Ministério do Turismo - Mtur), which offers a database for such services. A suitable tourist facilities improve the visitors' permanence and support and is also one of the requirements of the IDA and FS, when referring to dark sky parks according to their criteria. Furthermore, during each realized fieldwork we performed a checking inside the park conditions provided to the visitors.

### 2.1.4. Astrophotography

Astrophotography is a relevant part of this analysis and also in astronomy communication nowadays Fairbairn 2021. As the project is aligned with the touristic interest, exploring the visual aspect is an important strategy to promote this potential in the parks and increase the parks' publicity with the media and society. The rise of digital astrophotography has made it possible to be done not only by professionals, but also by amateurs and those interested in the beautiful images we see in the news. Astrophotography has had increasing success in Brazil in recent years. Therefore, there is an important tourist niche to be explored by astrophotography enthusiasts in the national scenario, and the Rio de Janeiro's natural parks can offer excellent destinations. For this research work, we took care to register the starry sky in the parks which we are visiting.

## 2.2. Connecting people with the starry night

Although it originated essentially as a research project, the Astrotourism in Brazilian Parks took a turn as of March 2022, when the team was invited to offer a public astronomical session at the headquarters of the Três Picos State Park, in Cachoeiras de Macacu/RJ. After this event, other parks have also become interested in promoting public astronomical sessions held by the project. Each session usually has three stages. In the first, we discuss the history of astronomy and its importance to mankind, presenting the naked eye sky using an astronomy laser pointer. The beauty of the starry sky is revealed in detail in the second stage, when planets, nebulae, star clusters and the Moon can be seen through telescopes. In the last stage, cameras are used to explore the starry sky beyond human eyes as a powerful tool to delight our view and show how technology applied to astronomy is also part of people's daily lives. Over time, the approach in

the astronomical sessions has been refined by adding audiovisual resources to the presentations. In some occasions, environmental interpretation and geotourism sessions have also complemented the astronomy activities, merging astronomy with other sciences in a multidisciplinary perspective. In June 2022, the project became the reference for the creation of the *Vem Ver o Céu* program, an Inea initiative to promote astrotourism in Rio de Janeiro state parks supporting by decree n.257 Inea 2022. Figure 1 shows a public astronomical session held by the team occurred at Restinga of Maricá Environmental Protection Area (APAMAR) on September 2022.



**FIGURE 1.** *Pointing to the stars* - Astronomical session held by the Astrotourism in Brazilian Parks project and promoted by Inea/SEAS-RJ *Vem Ver o Céu* program occurred at Restinga of Maricá Environmental Protection Area (APAMAR) on September 2022. Credits for Douglas Lopes.

The original proposal was to conduct fieldwork in five national (managed by ICMBio) and 11 state parks in Rio de Janeiro (managed by Inea) over 24 months. At the current stage, for both public astronomical and research sessions, we have already visited the Restinga de Jurubatiba National Park (PNRJ), the Montanhas de Teresópolis Municipal Natural Park (PNMMT), the Restinga of Maricá Environmental Protection Area (APAMAR), the Costa do Sol State Park (PECS), the Serra da Tiririca State Park (PESET), the Desengano State Park (PED) and the Três Picos State Parks. The expansion of the project to national parks in other Brazilian states is planned for 2023.

## 3. The Rise of Astrotourism - Part I: The Três Picos State Park

The Três Picos State Park (PETP) is a UC created in June 5th, 2002 and is located in the Serra do Mar of Rio de Janeiro state. The park's name comes from the granite hill of Três Picos, formed by Pico Menor, Pico Médio and Pico Maior of Friburgo. It is an important remnant of the Atlantic Rain Forest biome, presenting a huge biodiversity. PETP is the largest fully UC in the Rio de Janeiro state, with a total area of approximately 59,000 hectares bordering the counties of Nova Friburgo, Cachoeiras de Macacu, Teresópolis, Silva Jardim and Guapimirim. According to the park's management plan Inea 2009, its objectives are to preserve the remnants of the Atlantic Forest and its rare, endemic and endangered species, as well as to stimulate scientific

research and ensure the sustainable management of mineral and water resources.

### 3.1. Close to the Nature

The public useful recreation activities in PETP include hiking with interpretation and environmental education, bathing in rivers and waterfalls, contemplative visits, climbing, and camping. Among the main tourist attractions we cite the millennial Jequitibá, the Ruins of the Old Railroad Track, the Sete Quedas and Furna da Onça waterfalls, the Vale da Revolta and Jacarandá rivers, and the viewpoints Mulher de Pedra, Torres de Bonsucesso, Dois Bicos, Caixa de Fósforo, Pico da Caledônia and Três Picos, with their respective trackings Inea 2009. In the park is possible for the visitor to establish the closest contact with nature throughout the year months.

### 3.2. Close to the Stars

Our activities at PETP comprised four visits conducted between July 2021 to March 2022, related to our previously outlined schedule in the application for overnight access to the park. The visit sites were chosen in order to cover the geographical scope within the park and due to the fact they are known tourist destinations. The visits were conducted on locations and dates, as follows:

- 2021, July 10 and 11: Starting PETP activity in Salinas, Nova Friburgo (Location Salinas on Table 1). On this occasion, we took light pollution measurements and astrophotography of the night.
- 2021 July 27: technical visit to Vale dos Deuses headquarters in the Salinas, Nova Friburgo. We hiked the trails to the Mirante da Caixa de Fósforo and Cabeça do Dragão, took light pollution measurements at the ground of the Cabeça do Dragão (Location Cabeça do Dragão on Table 1) ascent and make astrophotography at the same point.
- 2021 September 04 and 05: technical visit to the Vale da Revolta Nucleus, located at Teresópolis. We walked the track of Pedra do Elefante (Location Pedra do Elefante on Table 1) lookout for measurements of light pollution and photographic records, we evaluated the tourist facilities and completed the activity at the visitors center’s helipad (Location Vale da Revolta on Table 1) to light pollution quantification and astrophotography exploring throughout the night.
- 2022 March 06 and 07: visit to the park’s Administrative Headquarters at Núcleo Jequitibá, Cachoeiras de Macacu (Location Núcleo Jequitibá on Table 1), and to Pico da Caledônia (Location Pico da Caledônia on Table 1), one of the Park’s most appealing tourist spots. We tracking to the peak, took SQM measurements to generate a light pollution map and astrophotography. On this occasion we stayed overnight at the administrative headquarters, complemented this visit with additional astrophotography and we held a public astronomical observation session with the park rangers and the invited local people.

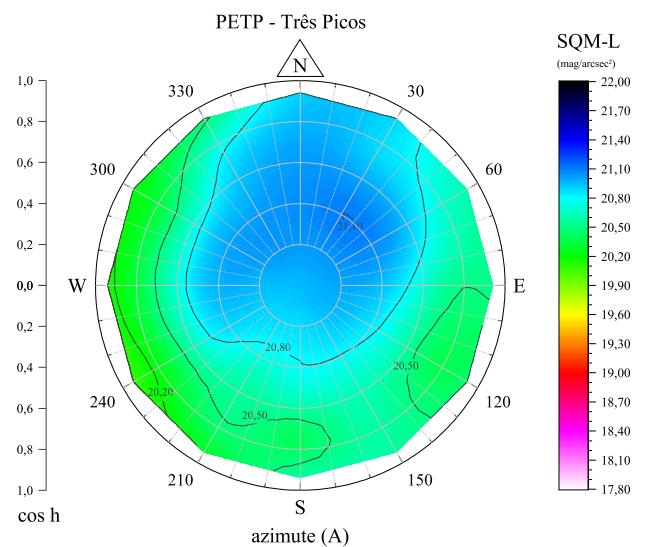
### 3.3. Light pollution maps

The quantification of light pollution at PETP is one of the pioneer results of this work. It is not only important for the analysis for astrotourism, but it can also be used as a valuable resource for estimating the possible environmental fauna and flora populations impact may eventually be subjected in these areas. Thus, this work is also a future source of data for environmen-

**TABLE 1.** Sky brightness obtained at zenith using the SQM-L at the visited locations in the Três Picos State Park

Location	Date	SQM <sub>max</sub>	SQM <sub>ave</sub>
Salinas	20210711	21.14	21.07
Cabeça do Dragão	20210727	21.05	20.96
Pedra do Elefante	20210904	20.16	20.11
Vale da Revolta	20210905	20.59	20.54
Núcleo Jequitibá	20220307	21.14	21.08
Pico da Caledônia	20220307	21.11	21.04

tal researchers. In addition to the light pollution maps, we also recorded the measurements of sky brightness at zenith for several data collection points. This data is important for comparing the measurements obtained at PETP with light pollution determinations made in other DSPs around the globe. Table 1 presents the measurements taken with the SQM-L photometer at 6 visited sites at PETP throughout the fieldwork. For each take, 20 measurements were taken with the SQM pointed at the zenith. In the table, we indicate the dates of the measurements, followed by their respective maximum and average values. As an example of the maps we obtain, the figure 2 shows the light pollution map obtained for the Vale dos Deuses, Salinas, in the hike of Cabeça do Dragão. Our color scale was chosen to cover urban night skies (SQM less than 17.8 mag/arcsec<sup>2</sup> magnitude) up to free of light pollution skies (SQM equal to 22 mag/arcsec<sup>2</sup> magnitude), which correspond to bortle scale ranging from 9 to 1, respectively. In this figure, the predominance of green and blue colors indicates an excellent quality sky for astrotourism, with reduced light pollution, especially in the northern direction (N).



**FIGURE 2.** Light Pollution Map obtained in the Vale dos Deuses - PETP. The Azimuth (A) values vary from 0 to 360° and the height angle (h) from 20 to 90°. N, S, W and E indicate the cardinal points.

## 4. Discussion

The analysis carried out in the Três Picos State Park is pioneering in several aspects. It is the first to perform in Brazil, an unprecedented quantification of light pollution and to relate the climatic and tourist facilities features to astrotourism potential.

Our results presented and discussed in this section set PETP as a promising park for astrotourism for all intends and proposes, especially for activities carried out in the winter months, displaying better weather conditions with low levels of cloud cover according to INMET meteorological data. Challenges, however, exist, especially related to the need for improvement the tourist facilities in the cities surrounding the park, and specially the urgency of governmental efforts to avoid the increase of light pollution in the three municipalities visited, especially Teresópolis, which has a more direct impact on the quality of the sky seen in the Vale da Revolta location.

Analysis of the Table 1 shows that the sky brightness at zenith for the locations of Salinas and Pedra do Dragão, Núcleo Jequitibá and Pico da Caledônia are equivalent, with very similar SQM mean values of sky brightness, within the uncertainties. These sites also have the highest SQM values, indicating darker skies, in our sample. The lowest registered data for the Vale da Revolta Headquarters and the Pedra do Elefante indicate skies more affected by light pollution, due to that the proximity of these sites to the city of Teresópolis and metropolitan border of Rio de Janeiro City. All the measurements presented were made under good weather conditions, with suitable lunar phases, although the sites had varying altitudes. The Milky Way was observed at zenith with the naked eye in all locations and also along the mountains as seen in Figure 3 that shows a magic view captured by long exposure astrophotography at Salinas on July 2021. Although care was taken to not include light pollution quantification with the Milky Way stream crossing the zenith, measurements taken during the winter may be slightly underestimated. However, we believe that the small differences are covered by intrinsic uncertainties of the SQM-L and those generating from the quantifying process (standard deviation). This value, in our analysis, is taken as  $0.2\text{mag}/\text{arcsec}^2$ .

The sky quality at the visited locations at PETP set on the same level as some of the internationally certified dark sky parks by IDA and FS, as described in item 1.1. The average zenith SQM value for all collected data at PETP (Table 1) is  $20.80\text{ mag}/\text{arcsec}^2$  (standard deviation of 0.4) yielding an approximate Bortle scale of 4.5 and NELM (Naked Eye Limit Magnitude) equal to 6.0. According to Kyba et al. 2023 this value is 1.2 magnitude above the global average NELM reported from the Globe at Night data base in recent analysis. This results is deeply remarkable, opening a path for the park to claim, in the future, the same condition already accomplish by the Desengano State Park and many others of international prestige. Furthermore, this fact support the establishment high mountain regions of the Rio de Janeiro state, especially the northeastern slope of the Serra do Mar, as a remarkable spot for this type of tourism, put down municipalities as potential places to astrotourism stakeholder offer as well as a sustainable economy based activity.

In order to enhance the traveler experience, it is also possible to aggregate other services to the astrotourism, taking the tourist beyond the universe, joining interpretative guiding trackings focused on environmental education, experiencing the local gastronomy and immersing the stakeholder in the culture of local communities. This form of integrated tourism has in PETP a place of imminent expansion. The diversification of attractions can further allow the development of specific tourist planning, aiming to exceed the stakeholder expectations. Furthermore, it is possible to create a calendar of astronomical phenomena to explore events, star parties, astrophotography workshops and safaris, amateur astronomy engaging meetings, full moon walks, and exploring scheduled stary sky protection dates. The multidisciplinary connection provided by astrotourism benefit the

awareness the environment significance for the collective welfare, which encouraging changes in people habits that contribute to environmental preservation and social commitment.



**FIGURE 3.** *Close to the stars* - An astounding view of the Milk Way captured at Salinas, Nova Friburgo-RJ, on winter of 2021. On the background the Pedra do Capacete (right) and the Três Picos of Salinas (center), tourist park symbol. Credits for Igor Borgo and Astrotourism in Brazilian Parks project.

*Acknowledgements.* The authors would like to thank the managements of the Instituto Estadual do Ambiente (Inea), Secretaria do Ambiente e Sustentabilidade (SEAS-RJ) do estado do Rio de Janeiro and the Instituto Chico Mendes para a Conservação da Biodiversidade (ICMBio) for their support during the visits to the parks, the park rangers and other staff of the visited UCs, and all the people who have participated the public astronomical sessions held by the project.

## Referências

- Alcázar, E. J., 2017, Revista Forum Calidad, año 28, 282, 42  
 Bortle, J. 2011, Sky & Telescope, 126-129  
 Collison, F. & Poe, K., 2013, Tourism Management Perspectives, 7, 1-15  
 Fairbairn, C., 2021, Revista Brasileira de Astronomia, Ano 3, N.10, 26-36  
 Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C., Elvidge, C., Baugh, K., Portnov, A., Rybnikova, N., & Furgoni, R., 2016, Science Advanced, 2: e1600377  
 Fayos-Solá, E., Marín, C., Jafari, J., 2014, Revista de Turismo y Patrimonio Cultural, Vol. 12, N° 4, 663.  
 IDA, IDA - International Dark-Sky Association, 2018, International Dark Sky Park Program Guidelines  
 INEA, 2009, Plano de Manejo - Parque Estadual dos Três Picos (Rio de Janeiro: Instituto Estadual do Ambiente do Estado do Rio de Janeiro)  
 Inea, Instituto Estadual do Ambiente do Rio de Janeiro, 2022, Resolução n. 257, 23 de junho de 2022.  
 IUCN - International Union for Conservation of Nature, 2009, Dark Skies Advisory Group (DSAG).  
 Kyba, C., Altintas, Y. O., Walker, C. & Newhouse, M., 2023, Science, 379, 265-268.  
 Marins, J. R., Mansur, S., Moreira, C. D., Riski, L. & Souza, M., 2022, Sky's Up - Global Astronomy Magazine, Volume V, July  
 Mello, D. R. C., Gomes, F. A., Borgo, I. & César, R. G., 2022, Revista Ciência Hoje, 390  
 Mello, D. R. C., Borgo, I., Gomes, F. A., César, R. G., & Silva, E. P., 2022, Revista Brasileira de Astronomia, Vol. 4, N. 15, 19-27  
 Sánchez de Miguel, A., Aubé, M., Zamorano, J., Kocifaj, M., Roby, J. & Tapia, C., 2017, Monthly Notices of the Royal Astronomical Society, Volume 467, Issue 3, 2966–2979  
 Stimac, V., 2019, Dark Skies – A Pratical Guide to Astrotourism, (Singapore: Lonely Planet Global Limited)  
 Zamorano, J., Sánchez de Miguel, A. S., Nievas, M & Tapia, C., 2014, LICA report, version 1.1