



**STARLIGHT  
RESERVE  
CONCEPT**





# Starlight Reserve

Concept  
Dimensions  
Categories  
Criteria  
Recommendations

March 2009



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UNESCO-WHC (Initiative Astronomy and World Heritage)  
MaB Urban Ecology Programme of UNESCO  
IAU (International Astronomical Union)  
UNWTO (World Tourism Organization)  
OTPC-IAC (Instituto de Astrofísica de Canarias)  
CIE (International Commission on Illumination)





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## Background

The Declaration in Defence of the Night Sky and the Right to Starlight was approved during the Starlight Conference, held on the island of La Palma in April 2007. It constitutes the general and conceptual framework of the Starlight initiative. The proposal to develop a "Starlight Reserve" concept was one of the additional recommendations to the Starlight Declaration, to be carried out with the support of the Organizations that promoted the Declaration and the Starlight Scientific Committee, in cooperation with the World Heritage Centre through its Thematic Initiative "Astronomy and World Heritage".

Between 10 and 19 October (2007), the participants in the Working Meeting "Starlight Reserve Concept", held at the UNESCO HQ, Paris, World Heritage Centre, agreed the development of its contents and action plan, as it is stated in the following introduction:

*Recognizing* the importance to promote the Declaration in Defence of the Night Sky and the Right to Starlight (adopted in La Palma, April 2007) through the different UNESCO Programmes and Initiatives within the framework of the UNESCO

Conventions,

*Recognizing* that light pollution must be considered as an imminent threat to the environment, as well as that climate change poses a threat to the outstanding universal values of World Heritage sites,

*Recognizing* that the preservation of dark skies is an important and necessary part in the process of the protection and safeguarding of natural and cultural properties worldwide,

*Following* the call of the UNESCO Director-General for "an integrated approach to issues of environmental preservation and sustainable development" (the UNESCO publication "Case Studies on Climate Change and World Heritage"),

the participants of the joint working group on "Starlight Reserve Concept" and the Initiative "Astronomy and World Heritage" recommended adopting the following plan of actions aiming:

✧ to elaborate the Concept of "Starlight Reserve";

✧ to identify the different categories of areas, reserves and properties accordingly to this Concept;

✧ to establish general technical recommendations in regard to the starlight protection, related to the safeguarding of natural and cultural properties, light pollution and intelligent lighting;

✧ to integrate these recommendations to the different World Heritage Programmes and Initiatives;

✧ to evaluate the possibilities of the nomination of the "Starlight Reserve" on the World Heritage List and/or as the Biosphere Reserve.

The Working Group "Starlight Reserves and World Heritage" met on March 11<sup>th</sup>, 2009 in the framework of the International Workshop and Expert Meeting "StarLight Reserves and World Heritage. Scientific, Cultural and Environmental Values" for the revision of this document. This Workshop was organised by UNESCO-World Heritage Centre, International Astronomical Union (IAU), and Instituto de Astrofísica de Canarias (IAC), with the support of the Fuerteventura Island Government.



## Definition

A Starlight Reserve is a site where a commitment to defend the night sky quality and the access to starlight has been established. Its main function will be to preserve the quality of the night sky and its associate values, whether they are cultural, scientific, astronomical, natural, or landscape-related.

A Starlight Reserve will have a core or dark zone. This is an unpolluted area where natural night sky light conditions are kept intact. This core zone will be protected by a buffer or protection zone to avoid the adverse effects of air and light pollution reaching the core zone. Beyond the buffer zone, there may be an external zone where criteria for intelligent and responsible lighting will be enforced, along with protection of the night sky from other harmful factors such as light pollution.

Each Starlight Reserve's requirements will be specified based on the characteristics, unique features, and functions of the site. These should be related to the preservation of the quality of astronomical observations, wildlife conservation, nighttime landscapes, or the cultural heritage.

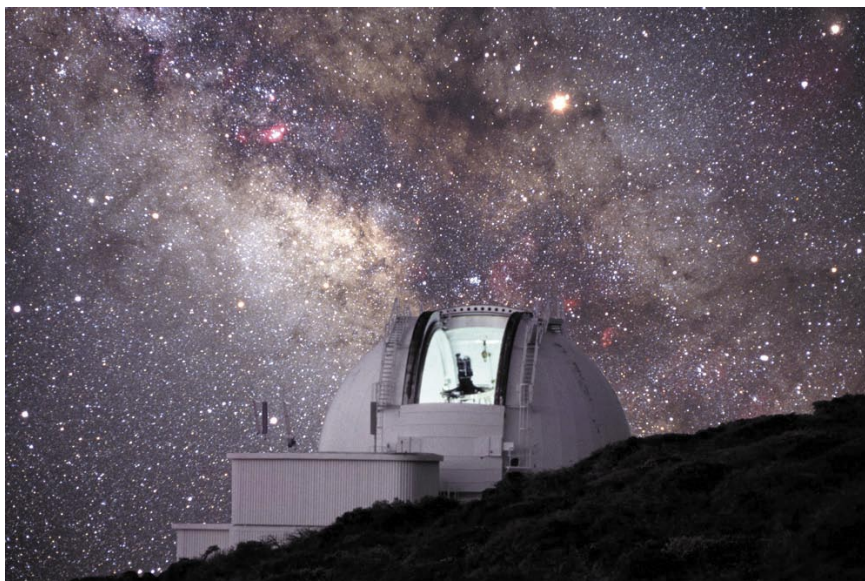
A Starlight Reserve declaration will be accompanied by a participative action plan and a group of recommendations aimed to preserve and recover the night sky quality up to the feasible limits, paying attention to the related cultural, educational, scientific and environmental benefits.

The objectives and functions of Starlight Reserves are guided by the principles contained in the Declaration in Defence of the Night Sky and the Right to Starlight.

# Starlight Reserve



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# Dimensions of the Starlight Reserve Concept

**“Access to knowledge, armed with education, is the key to allow the integration of science into our present culture, contributing to the advance of humankind. The dissemination of astronomy and the scientific and cultural values associated with the contemplation of the universe should be considered as basic contents to be included in educational activities, which require a clear and unpolluted sky and proper training of educators in these subjects”**

Declaration in Defence of the Night Sky and the Right to Starlight.

## The cultural dimension

“The skies, which have been, and are, an inspiration to all humanity, are becoming obscured and even unknown to the younger generation. An essential element of our civilisation and culture is rapidly becoming lost, and this loss will affect all countries on Earth”<sup>1</sup>.

Interest in astronomy, or simple contemplation of starry skies, has always had profound implications for philosophy, science, arts, culture and for the general conception of the universe in every community all over the world. Each place has its own view of starlight handed down through generations: legends, folk tales, children stories, and traditional festivals are critically endangered worldwide. Putting into value, protecting and promoting the tangible and intangible cultural heritage associated to night sky vision, usually poorly known and little valued, and often in danger, would be an essential function of Starlight Reserves.

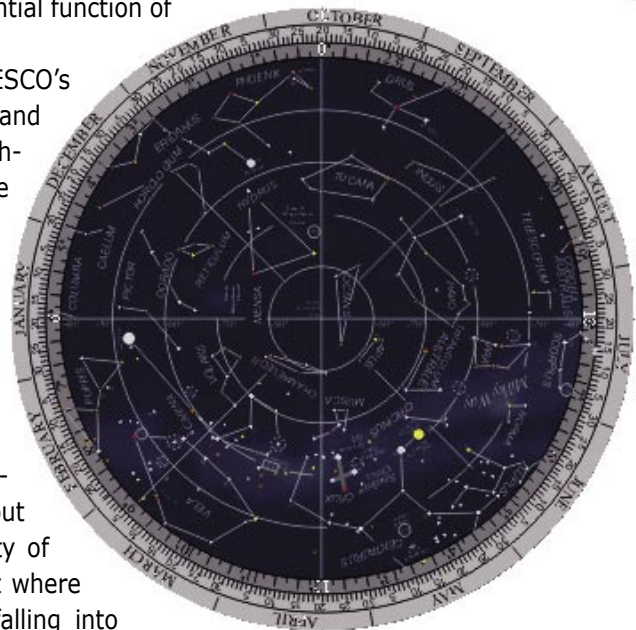
Following the example of UNESCO’s thematic initiative “Astronomy and World Heritage”, the establishment of links between science and culture, on the basis of research aimed at acknowledging the cultural and scientific values of heritage sites connected with astronomy, should be promoted.

A large part of the present generation are the first in history that have grown up without a direct contact with the beauty of a starry sky, in an environment where these cultural references are falling into the oblivion. Therefore, we need improving education systems, as well as dissemination and access to available information on the cultural dimension and value of the night sky. Even though astronomy is normally included in educational programmes, it is not often linked with an area’s related cultural heritage.

The night sky should be kept as one of the big windows open to the inspiration and cultural enrichment of human communities, with new generations becoming their best guardians.

## Preservation of the astronomical sky quality

“The sky, our common and universal heritage, is an integral part of the environment perceived by humanity. Humankind has always observed the sky either to interpret it or to understand the physical laws that govern the universe”<sup>2</sup>.



<sup>1</sup> Declaration of the IAU/ICSU/UNESCO-1992.

<sup>2</sup> Explanatory Note concerning the Proclamation of 2009 as International Year of Astronomy (33<sup>rd</sup> session of the UNESCO General Conference).

Astronomy has had an undeniable influence within science development and has contributed to many technological advances that defined human progress throughout the history. Nevertheless, the continual stream of benefits brought by this branch of science is often not known by most people.

Ground-based observatories are exceptional windows for the observation of the universe, and they have provided the vast majority of our knowledge of astronomy. However, present technical requirements restrict suitable areas to very specific and limited locations offering good conditions for the development of advanced astronomy, and of optical and infrared astronomy in particular.

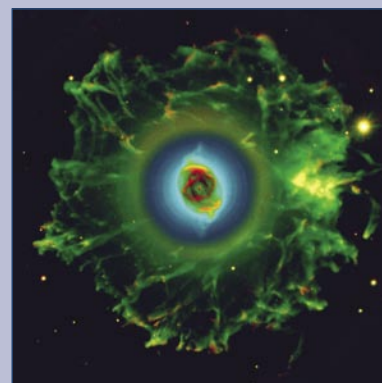
The Earth's atmosphere is a major limiting factor for astronomy at optical wavelengths. Although astronomy from space does not suffer from this blurring, space astronomy is extremely expensive. The very best astronomical sites are places located at high altitudes, with little turbulence, such as in the west coasts of continents, or on some oceanic islands. They must also be located at latitudes with good weather<sup>3</sup>, with little air pollution and low aerosol content. Except for a few exceptional cases, high mountain areas isolated from the temperature of the ocean and coastal mountains near to cold oceans with stable, subtropical anticyclone conditions are the best possibilities. These are a limited resource that needs to be protected.

However, the sky quality in many of these privileged zones can be perturbed by external factors of different kinds. Optical astronomy needs dark skies. Therefore light pollution is one of the main threats because it increases the natural sky brightness. Atmospheric pollution is a further impact to the astronomical quality of the sky.

Radio astronomy made decisive contributions to several fundamental discoveries in the last century. Nowadays this branch of astronomy is also threatened due to radio interference, generated by several causes such as mobile phones or radio/TV frequency signals, which invade the radio-electric spectrum in which astrophysical observations are made.

In addition to the very best astronomical sites, there are many other valuable locations that must also be identified and preserved. These other sites are excellent for many aspects of astronomical research, and are also valuable for educational and outreach activities.

The defence of astronomical sky quality, as well as the establishment of measures and regulations to avoid its possible deterioration, is the basic function of the application of the Starlight Reserve concept to the best sites for astronomical observation. Involvement of people, through education and distribution of information on astronomy and its benefits, is key to achieving conservation of the sky for astronomy and science.



**“Areas suitable for unimpaird astronomic observation constitute an asset in short supply on our planet, and their conservation represents a minimum effort in comparison with the benefits they contribute to our know-how and to scientific and technological development. The protection of sky quality in these singular places must be given priority in regional, national, and international scientific and environmental policies. The measures and provisions must be made to safeguard clear skies and to protect such spaces from the harmful effects of light, radio-electric emissions, and air pollution.”**

Declaration in Defence of the Night Sky and the Right to Starlight.

<sup>3</sup> Best sites for optical astronomy with these characteristics are found in: the Canary Islands (La Palma-Tenerife), the coastal mountains of Chile, the Hawaiian Islands (Mauna Kea, Haleakala), Baja California and coastal mountains of southern California, Arizona, Namibia, where there is a high plateau. Singular locations are also found in Uzbekistan, North Africa or Argentina, and also some interesting areas in Antarctica.

**"The negative effects of emissions and of the increased intrusion of artificial light on the atmospheric quality of nocturnal skies in protected areas have an impact on several species, habitats, and ecosystems. Control of obtrusive light must be a basic element of nature conservation policies and should be implemented in the management plans of the different types of protected areas to fulfil their mission in protecting nature and biological diversity".**

**"Sites included in the World Network of Biosphere Reserves, Ramsar Wetlands, World Heritage Sites, National Parks, and all those protected areas which combine exceptional landscape and natural values relying on the quality of their night sky, are called to include the protection of clear night skies as a key factor strengthening their mission in conserving nature."**

Declaration in Defence of the Night Sky and the Right to Starlight.

## Clear Skies and Biodiversity

The loss of quality of nocturnal skies, caused by the negative effects of atmospheric emissions and of the increased intrusion of artificial lights, has become a serious threat for many species, disturbing their habits and habitats, as well as the basic functions of ecosystems.

Darkness and natural night light are indispensable for the healthy functioning of organisms and ecosystems. We usually forget that life lives 24 hours a day and that ecosystems adapted themselves to the natural rhythms of the moon and stars during millions of years of evolution. As over half of the creatures living on this planet are nocturnal, any degradation in the quality of sky, by day or by night, is having a profound effect on their behaviour and on the equilibrium of the biosphere. In addition, many diurnal species adjust their vital cycle according to night duration.

Light pollution, in particular, has been shown to have a widespread, negative impact on many different species. Scientific evidence for this impact in migratory birds, hatchling sea turtles, and insects is striking, because of the large-scale mortality that has occurred as a result of artificial night lighting. Light pollution can confound animal navigation (many species use the horizon and stars for orientation), alter competitive interactions, mutualisms and reproduction behaviour, change the natural predator-prey relationship and even affect animal physiology. Amphibians are well-studied in this sense, as well as a number of nocturnal or crepuscular mammals such as bats, some primates, many rodents and marsupials, which all suffer from what is now called "biological photopollution". Disturbing data on light pollution effects on flora and phytoplankton are also being obtained. This is because many plants time their development, growth and flowering behaviour by measuring the seasonally changing length of the night, which is impossible when there is light pollution.

Applying the Starlight Reserve concept, especially in the case of natural areas, would allow establishing new bases to safeguard Earth's biological diversity. The night sky quality dimension should be at least included in the management and conservation of protected areas and important habitats. Ramsar wetlands, natural areas declared World Heritage Sites, Biosphere Reserves, National Parks, marine sanctuaries, and other protected areas have to face up to a new responsibility: saving life at night.



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We should not forget that the increasing artificialization of nocturnal light is causing negative effects also to the human species, with a demonstrated repercussion on people's health and behaviour.

## Nocturnal Skyscapes

A night starry sky can be considered one the most awesome natural shows we can nowadays observe. Landscapes related to the night sky can feature incredibly different displays, where "landscape" denotes an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors<sup>4</sup>. The light of stars and other heavenly bodies has always enriched terrestrial nature's display as well as human habitat, creating reference landscapes traditionally perceived by people as an integral part of their natural and cultural heritage. Nevertheless, the skyscape nocturnal dimension, in spite of its diversity and magnificence, is still the most hidden aspect of the landscape.

We must immediately value and preserve those areas where natural light still prevails - those places and environments characterized by the natural rhythm of the Sun and Moon cycles, clean air, and dark nights unperturbed by artificial light. These natural nightscapes, often associated with some kind of protected area, or left aside from intensive human occupation, should be considered as a resource of unaccountable experiences and perceptions of natural nocturnal landscapes.

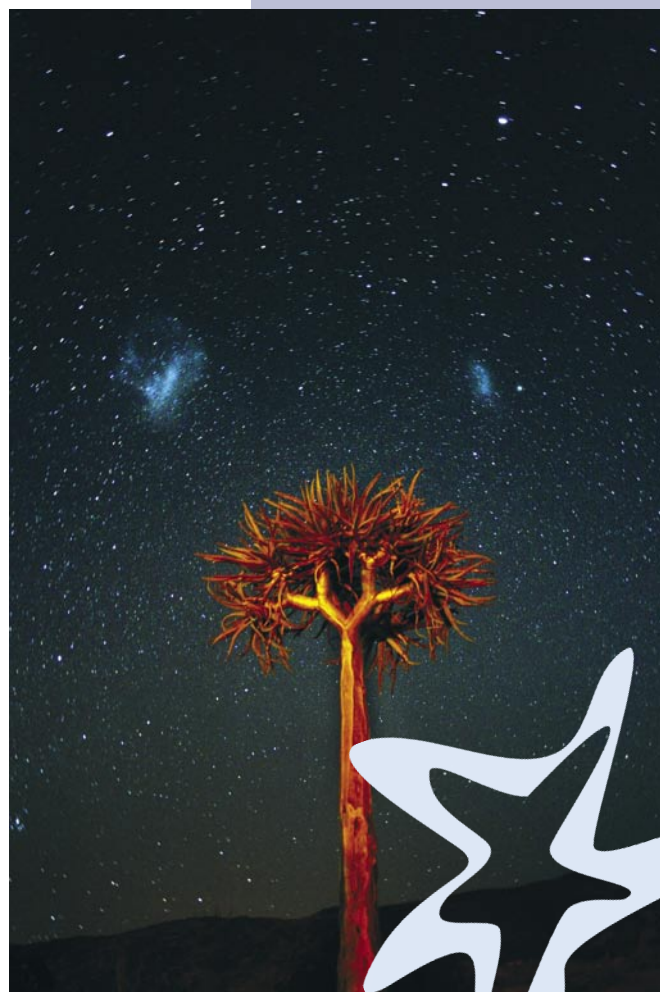
Nightscapes can be very diverse, starry landscapes related to rural areas, urban oases, or sites associated with astronomical heritage, all of which are worthy of special attention because of their increasing deterioration rate.

Application of the Starlight Reserve concept to this scope aims to protect and/or recover starlight-related landscapes, guarantee their quality, and establish the appropriate planning and management measures, where protection means action to conserve and maintain the significant or characteristic features of a landscape, including its associated natural, cultural and heritage elements.

<sup>4</sup> European Landscape Convention

**"Mindful that a starry night sky forms an integral part of the landscape perceived by the inhabitants of every territory, including urban areas, the landscape policies established in the different juridical systems need to adopt the pertinent standards for preserving the quality of the night skyscape, thus allowing them to guarantee the common right to contemplate the firmament".**

Declaration in Defence of the Night Sky and the Right to Starlight.



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**“The intelligent use of artificial lighting that minimises sky glow and avoids obtrusive visual impact on both humans and wildlife has to be promoted. Public administrations, the lighting industry, and decision-makers should also ensure that all users of artificial light do so responsibly as part of an integral part of planning and energy sustainability policies, which should be supported by light pollution measuring, both from the ground and from space. This strategy would involve a more efficient use of energy so as to meet the wider commitments made on climate change, and for the protection of the environment”.**

Declaration in Defence of the Night Sky and the Right to Starlight.

## Intelligent Lighting and Climate Change

The natural night sky light comes from starlight, zodiacal light (sunlight scattering from dust in our solar system), and airglow (atoms and molecules in the atmosphere that glow in the night after absorbing solar radiation) in roughly equal quantities. Even a small amount of artificial light interferes with this delicate balance, changes the colour of the sky, and overwhelms the starlight. Light pollution has become a worldwide problem as it is gradually diminishing the capacity to observe the stars. This new kind of waste originates cultural, environmental and even energy impacts, with unforeseeable consequences.

Light pollution can be defined as the introduction by humans, directly or indirectly, of artificial light into the environment. Avoidable light pollution refers to light flow emitted at night by artificial light sources which are inappropriate in intensity, direction and/or spectral range, unnecessary to carry out the function they are intended for, or when artificial lighting is used in particular sites, such as observatories, natural areas or sensitive landscapes.

Among all causes having a negative effect on night sky quality, light pollution shows the highest immediate risks but, at the same time, it can be reduced through viable solutions. Irresponsible lighting includes over-illumination, which makes an excessive and unnecessary use of artificial light, as well as poorly designed luminaires which cause glare or sky glow.

The Starlight Saving Time takes into account the time when artificial lighting is strictly necessary<sup>5</sup>. Dark Time saves energy, saves our heritage, and promotes life quality, as well as cultural and scientific investigation.

The common factor of these phenomena is the loss of the capacity to observe the stars, together with unnecessary impacts on people life quality, waste of energy, habitat deterioration and negative effects on wildlife.<sup>6</sup>

A Starlight Reserve would be an area where all the possible efforts are made to protect and, eventually, restore the pristine quality of the night. Any lighting in these areas must be of the highest quality and be an example to the rest of society. Intelligent lighting systems should be used, creating a reference and improving best-practice models for the minimization of all the negative effects of artificial illumination at night. Within Starlight Reserves, any artificial lighting should only be designed to provide the necessary visual information, avoiding light noise and energy waste. Their outdoor lighting policy aims to guarantee sky quality and people's and wildlife's right to the starlight.

Limiting the emission of particles into the atmosphere and promoting an intelligent, more energy efficient lighting system, contributes to the double objective of fighting against climate change and recovering starry skies.

<sup>5</sup> Sky glow is a prime problem for star observation, because it reduces contrast in the night sky to the extent where it may become impossible to see all but the brightest stars.

<sup>6</sup> Some of the less energy-consuming lamps (e.g. high and low pressure sodium) emit a type of light which is more useful for humans and whose spectrum is less harmful for several animal species, man included.

# Starlight Destinations

Tourism, one of the most important and innovative activities on our planet, could act as the vector of a new alliance to promote the quality of the night sky.

Clear sky availability can rightly constitute an asset for the development of specific products geared towards scientific or cultural tourism. But we should not forget the potential value of a starry sky in any tourist destination, as an additional scenic element.

The firmament, as a scenario for tourism in modern times, has been present as a basic reference point in historical destinations. This vital resource has almost fallen into oblivion due to tourism's rapid development, standardising and massification. The present challenge is to reintroduce this resource as a basic part of the offer for those destinations which still have a chance to recover the clarity of their night sky.

At times, the starry sky and other nocturnal phenomena form part of the very essence of the tourism product, such as in the case of observations of the Northern Lights, eclipses, visits to astronomical observatories, the sailing holidays featuring navigation by the stars, some pilgrimage routes, or the innovative visions offered by desert tourism at night. Recitals of local stories and tales related to stars and festivals under the starry sky will add tourist interest, besides being an effective educational program for children and contributing to folklore protection and local community conservation.

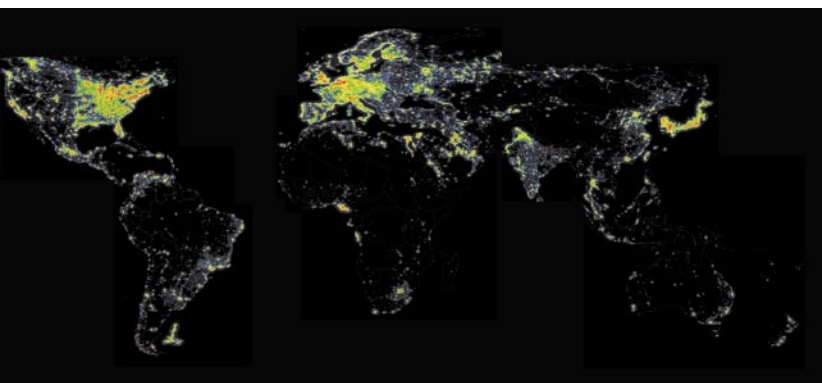
The cultural heritage associated with astronomy, acts as motivation for many travellers nowadays. At present, new big opportunities arise for many locations and destinations in which heritage is connected with astronomy, including archaeoastronomical heritage, and intangible and oral manifestations, being them a potential attraction for the development of sustainable tourism. Stargazing could be a further activity to be included when developing a responsible ecotourism product.

Astronomy sites and their surroundings are also candidate areas for the development of innovative and respectful tourism activities, where, with intelligence, visits can be made compatible with the careful protection of the extraordinary natural conditions at such locations, and their quality for astronomical observation.

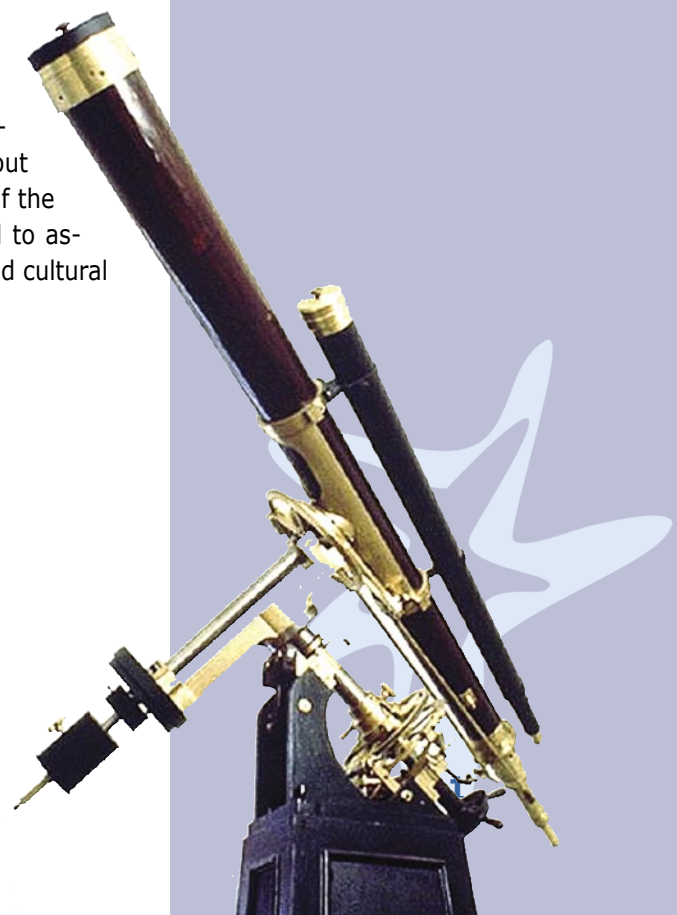
Any Starlight area, as a responsible tourist destination, has the purpose to safeguard and put into value its night sky quality as well as to raise awareness among local population about the advantages that a dark sky can bring to their economy. If the right conditions are met, innovating tourist products related to astronomical observation, natural lightscapes and the associated cultural heritage can be successfully promoted.

**"The intelligent use of artificial lighting that minimises sky glow and avoids obtrusive visual impact on both humans and wildlife has to be promoted. Public administrations, the lighting industry, and decisionmakers should also ensure that all users of artificial light do so responsibly as part of an integral part of planning and energy sustainability policies, which should be supported by light pollution measuring, both from the ground and from space. This strategy would involve a more efficient use of energy so as to meet the wider commitments made on climate change, and for the protection of the environment".**

(Declaration in Defence of the Night Sky and the Right to Starlight).



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# Categories

Several specific types of Starlight Reserves have been identified and defined. To date they cover the following categories:

**Starlight Heritage Sites**

**Starlight Astronomy Sites**

**Starlight Natural Sites**

**Starlight Landscapes**

**Starlight Oases - human habitats**

**Mixed Starlight Sites**

## Starlight Heritage Sites

Archaeological and cultural sites or monuments created by man as an expression of its relationship with the firmament, which reflect the development of astronomy and its manifestation in the arts and traditions.

They include:

- ✧ Monuments or groups of buildings related to astronomy, of outstanding value from the point of view of history, art or science.
- ✧ Relevant sites and manifestations of cultural heritage related to sky observation, including archaeoastronomical sites.
- ✧ Areas where still survive expressions of tangible and intangible cultural heritage associated with astronomy and starlight, including music, traditions, legends, folk tales, and folklore, of particular importance for education in astronomy and the development of research on cultural heritage and sky observation.
- ✧ World Heritage Properties and Biosphere Reserves.

## Starlight Astronomy Sites

Exceptional observation sites for optical, infrared, and radio astronomy, including potential future sites.

They include:

- ✧ Relevant astronomical observatories and their environment. Astronomical observatories by their nature are extremely sensitive to light pollution, as well as to atmospheric and radio electric pollution.



- ✧ Potential areas for advanced astronomical observation, recognised by the IAU and the international scientific community.
- ✧ Exceptional astronomical observation sites, whose characteristics give them a special interest for the development of educational and scientific activities or for the promotion and spreading of astronomy.

### Starlight Natural Sites

Natural areas where the integrity natural conditions, including natural night sky quality, are preserved.

They include:

- ✧ Habitats of particular relevance that host nocturnal wildlife species particularly sensitive to the loss of night sky quality or vulnerable to the effects of photopollution.
- ✧ Terrestrial and marine areas used as corridors and resting sites by migratory wildlife species whose habits and displacements could be affected negatively by glare or loss of natural sky brightness.
- ✧ Protected natural areas with a special relevance for the development of night-time environment research and management and the study of the natural patterns of light and dark.
- ✧ World Heritage Properties, Biosphere Reserves, Ramsar Sites and marine or terrestrial protected areas of international importance.
- ✧ All protected nature areas in general, since all species and ecosystems depend on natural cycles of day and night.

### Starlight Landscapes

Places where aesthetic manifestations of the night sky can be observed, as well as natural and cultural landscapes related to starlight where natural manifestations or human works beautifully blend with the view of the firmament.

They include:

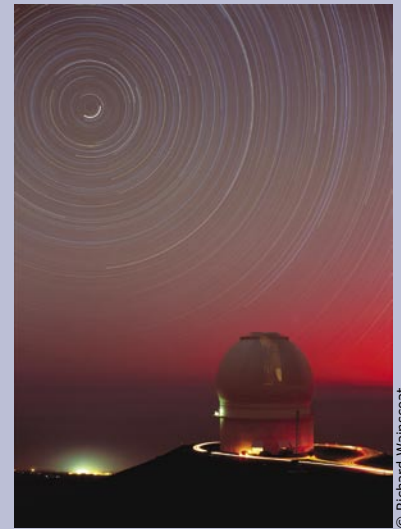
- ✧ Areas where the starry sky, as well as exceptional manifestations of light-related phenomena can be observed with high quality and aesthetic strength.
- ✧ Expressions of nature and geological monuments associated to the firmament and related phenomena, which create night landscapes of acknowledged value.
- ✧ Cultural landscapes or expressions of combined works of nature and of man where the astronomical dimension prevails, as well as associative cultural landscapes related to starlight.
- ✧ Natural Heritage Properties (cultural and associative landscapes) and Biosphere Reserves.

### Starlight Oases – Human Habitats

Populated areas relatively free from the negative effects which impede star viewing and decrease night sky quality.

They include:

- ✧ Rural areas of outstanding singularity where the starry sky view is part of their recognised identity and values.
- ✧ Small villages keeping their night sky reasonably free from atmospheric and light pollution effects, where this resource is considered a social, environmental and citizens' cultural right.



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- ✧ Tourist destinations considering the night sky an important resource, which committed themselves with the conservation of its quality and with the development of activities based on or related to astronomy and the enjoyment of the night sky.

Within urban areas, the Urban Star Parks, whose requirements are of course less strict than those established for Starlight Reserves, carry out a very important public function, especially related to education, amateur astronomy or simple stargazing, as well as promote recovering of emblematic nocturnal skylscapes<sup>7</sup>.

### **Mixed Starlight Sites**

Sites that combine two or more of the previously described categories.

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<sup>7</sup> Urban Star Parks are defined within the Urban Star Park Guidelines (RASC-USP). March 2008.



## Benefits



- ✧ To recover and conserve the cultural heritage related to our natural nightscape and star observation.
- ✧ To preserve astronomy best sites as a common heritage, aiming at the development of science and the knowledge of the Universe, hence guaranteeing the benefits that are continuously originated by the advances of astrophysics.
- ✧ To maintain those areas with an exceptional starry night for public enjoyment, astronomy education, amateur astronomy observation, and artistic or aesthetic inspiration.
- ✧ To contribute to biodiversity conservation, protecting the species negatively affected by light pollution and maintaining the integrity of nocturnal habitats sensitive to sky quality degradation.
- ✧ To respect and promote night sky quality as an indisputable quality of protected areas and natural sites.
- ✧ To set the bases of an intelligent lighting culture - to be applied everywhere - that would allow the enjoyment of the night sky, minimise environmental impacts and make an efficient use of energy, limiting the negative effects on climate change.
- ✧ To open new windows to cultural and responsible tourism, taking advantage of starlight as a resource for the sustainable development of local communities.
- ✧ To integrate the night sky dimension in the World Heritage properties and the Biosphere Reserves, improving their functions and reach.
- ✧ To bring new dimensions to the management and conservation of protected areas, nighttime landscapes and related cultural sites.
- ✧ To open new windows to research, science, and education, in all night-sky related domains.



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# Directions for the Action Plan Objectives

Each Starlight Reserve should develop an Action Plan to formally state the active commitment in defence of the night sky and the right to starlight, where the main lines of action and the outlined objectives would be defined, according with the characteristics of each reserve. An ensemble of possible lines of action is listed here below as reference:

## Culture and Education

- ✧ To identify and promote initiatives to enhance the value of tangible and intangible cultural heritage associated with astronomy, hence reinforcing our astronomy-related knowledge and retrieve firmament-related marks in local cultures.
- ✧ To identify actions aimed at the conservation of astronomy-related cultural heritage.
- ✧ To develop research and dissemination actions regarding astronomy-related cultural heritage.
- ✧ To promote the astronomy and night-sky knowledge in education programmes.
- ✧ To promote artistic manifestations based on the defence of the quality of the night sky as a creative resource.
- ✧ To evaluate present-day indigenous artistic manifestations related to starlight.
- ✧ To promote actions to recover intangible cultural heritage (music, stories and tales), such as festivals under the starry sky, which will add tourist interest, besides being an effective educational program for children and contributing to folklore protection and local community conservation.

## Astronomical observation

- ✧ To identify the best sites for astronomical observation, as well as define the area to be preserved and the potential threats.
- ✧ To set up the appropriate measures to protect night sky quality in the best astronomical sites, considering this quality as a heritage to be preserved.
- ✧ To develop permanent educational and dissemination actions on astronomy, with the support of the scientific community and amateur astronomers.



- ✧ To develop awareness promotion initiatives for local population about the importance of astronomical observatories and the direct and indirect benefits generated by the development of astrophysics.

## Environment and biodiversity conservation

- ✧ To identify those species and habitats which could suffer a negative effect from night sky quality loss and light pollution, as well as their distribution range.
- ✧ To set up programmes to increase knowledge and understanding of the scope of the ecological consequences of artificial light at night.
- ✧ To incorporate night sky quality and prevention of light pollution in the management plans of protected areas.
- ✧ To establish cooperation actions with other protected areas which include the maintenance of unperturbed night skies in their management and conservation strategies.
- ✧ To develop inventory & monitoring networks able to identify the state, evolution and effects of the night sky quality within the vital signs of protected (natural) areas.

## Intelligent Lighting and Light Pollution

- ✧ To develop laws or bylaws regulating the requirements of outdoor lighting to guarantee the protection of night sky quality.
- ✧ To incorporate measures in favour of energy saving and night-responsible outdoor lighting in the reserve's energy strategy definition and planning.
- ✧ To develop reference actions connected with intelligent lighting design, in both the architectural field and in urban planning, as well as in engineering, and the development of infrastructure.
- ✧ To strengthen local authorities' commitment for night sky defence in their choice of lighting systems, to ensure that "the public sector sets a good example".
- ✧ To promote labelling in recognition of lighting fixtures and products whose design aims to preserve the quality of night sky.



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- ✧ To develop alliances with the main outdoor-lighting responsible actors, both public and private.
- ✧ To develop measures to avoid obtrusive light and improve the quality of life of local populations.
- ✧ To inform local populations properly about the adverse effects of artificial light at night and the existing solutions to reduce them, as well as of the environmental, personal and energy-saving benefits that night-sky respectful lighting installations entail.
- ✧ To establish measures to control light pollution also in and from the sea, either generated by platforms or over-illuminated ships and boats.

## Sustainable Tourism and starry skies

- ✧ To identify night-sky associated resources aiming to develop scientific and cultural tourism related to astronomy.
- ✧ To promote the exceptional nocturnal skylines as basic resources in a new generation of tourist products.
- ✧ To establish alliances between tourist agents to preserve and put into value the tangible and intangible cultural heritage connected with astronomy and star observation as a tourism resource.
- ✧ To support the development of responsible tourist products related to astronomical observatories and non-professional observation sites of interest.
- ✧ To incorporate the clear sky criterion in the strategies of sustainable tourism destinations.
- ✧ To promote the inclusion of responsible lighting and night sky protection within the responsible tourism certification criteria and eco-labels.

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## Core Zone

Within a Starlight Reserve, the core zone, or exclusion zone, is the unpoluted area/s where natural night sky light conditions are kept intact.

Core zones are conceived as true windows to the sky. They are areas where the night sky quality is extremely protected, to guarantee the Starlight Reserve basic functions related to starlight: observation, education, conservation of cultural heritage, sensitive habitat and wildlife protection, allowing at the same time the full enjoyment of starry skies by local populations and foreign visitors.

Artificial lighting shall have minimal effects on the environment in the core zones. They are therefore characterised by no artificial outdoor lighting.

The core zone would include areas whose ratio between the artificial sky brightness and the natural sky brightness<sup>8</sup> is  $< 0.1$ . They correspond to Class 1 and 2 sites<sup>9</sup> in the Bortle Dark-Sky Scale<sup>10</sup>.

## Criteria

A core zone is a dark area, void of any source of light or air pollution.

The determination of sky quality, taking into account the key factors in each category, should be defined and monitored through reliable methods, by using measurements from both Earth and space.

In the case of areas where optical astronomical observation is the first activity, the protection of the site has to be maximised, taking into account that a decrease in atmosphere quality could limit seeing, and that sky glow reduces the contrast that makes stars visible, altering observation conditions, leading to inability to do research. The installation and operation of radio communications stations are regulated, with a power flux density limit of  $W/m^2$  in force over the observatories<sup>11</sup>. Overflying traffic should also be restricted. In areas where radio astronomy observations are carried out, radio interference limits should be established to ensure that equipment and measurements at the observatories are not corrupted<sup>12</sup>.

Natural illumination conditions are primary attributes that must be taken into account in protected areas and when dealing with sensitive habitats and wildlife species, as well as some factors that may have a negative effect on biodiversity conservation. Among others, the use of those isolated lights which can dazzle some species of animals (causing collisions), and of lighting systems emitting in a harmful range, such as ultraviolet radiation and the blue part of the visible spectrum, which has an incontestable harmful effect on wildlife (insects, amphibians, fishes, mammals) will be avoided.

Within the core zone, if an illumination level is deemed necessary, then the full moon criterion ( $<0.27$  lux) should be used and it should be restricted to the immediate area to be illuminated.

<sup>8</sup> Cinzano, P., Falchi, F., Elvidge C.D. 2001, The first world atlas of the artificial night sky brightness.

<sup>9</sup> Used as a reference in the Dark Sky Preserves classification (IDA). <http://www.sky-andtelescope.com/resources/darksky/3304011.html>

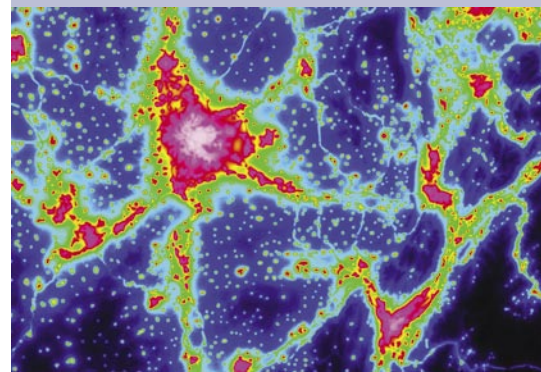
<sup>10</sup> Measuring sky glow, either using Cinzano's method, which requires a complex calibration, or through the Bortle scale, which need some astronomical knowledge, can result difficult to users. It can be more easily quantified by using a zenith Sky Quality Meter that measure sky quality in magnitudes per square arc-second ( $mag/arcsec^2$ ).

<sup>11</sup> Power flux density for any frequency must not be greater than  $2 \times 10^{-6} W/m^2$  in any part of the observatories, equivalent to an electric field intensity of 88.8 dB ( $\mu V/m$ ).

<sup>12</sup> According to the recommendations of IAU - 50 Commission.

# Zonation Criteria

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Lighting of monumental and cultural sites necessary for interpretative and security reasons would be designed avoiding any impact on the quality of the night sky and will be limited to the first hours of the night.

## Intelligent Lighting Buffer Zone

It is the area that surrounds the core zone, protecting it from the possible harmful effects that could deteriorate its night sky quality. Buffer zones can include small human settlements and activity areas.

A buffer zone, or high sensitivity zone, will include the nearby area that can be directly seen from the core zone, creating a security belt which guarantees that the effects of air or light pollution would not affect the core zone.

### Criteria

The buffer zone is considered a high sensitivity area where the lighting systems are specifically designed not to interfere at all on core zone's clearness conditions, observational requirements and natural sky brightness. In the buffer zone all sources of air pollution that can have a direct or indirect negative effect on the core zone's night sky quality will be eliminated.

Buffer zones would also include the corridors of migratory and nocturnal species, particularly sensitive to light pollution, which connect with the core zone.

Within the buffer zones, night sky protection measures shall also comply with the following principles:

- ✧ All luminaires, both public and private, shall focus their light emission on the area that needs to be illuminated, avoiding them being pointed towards the sky or the horizon, guaranteeing a high coefficient of utilisation (or utilance)<sup>13</sup>. All luminaires should have an Upward Light Ratio (ULR) of zero when installed or an intensity at and above the horizon plane of 0.49 cd per each klm of flux escaping from the luminaire.
- ✧ The luminaires should use optics appropriate for the elements to be illuminated and their location. Otherwise, screens or baffles should be used to avoid light spilling out of the area.
- ✧ All lighting installations must avoid over-illumination, or excessive luminance, complying with the recommended limits, taking also into account the effects of reflected light<sup>14</sup>.
- ✧ Starlight Saving Time: the use of outdoor lighting should be used only in hours when strictly necessary, especially in the case of road lighting, public areas, illuminated advertisements, commercial areas, parking and sport facilities. Dark Times should be established according to the values and activities carried out in the core zone which could suffer a negative effect: astronomical observation, tourism, educational tours, research, and biodiversity conservation management.
- ✧ Total elimination of the use of sky beamers and laser floodlights.
- ✧ In the case of illuminated advertisements, a discreetness criterion should be used, checking the best orientation of the lights, which should be aimed downwards. Advertisements and billboards must be turned off during the businesses closure hours.

<sup>13</sup>  $k \geq 30\%$  or  $u \geq 40\%$ .

<sup>14</sup> CIE/ISO Standards.



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- ✦ In agreement with the energy saving criteria, outdoor luminaires would always use the most efficient lamps with a suitable emission spectrum (see General Recommendations), whose contents of harmful materials are minimum. Their ultraviolet and blue emission should be absent or minimum, because of its adverse environmental effects.
- ✦ Road lighting shall be rigorously restricted to areas with justifiable needs. No road should be lit outside city limits, except at intersections where the luminaire front glazing should be kept at or near parallel to the surface in order to obtain a light intensity at or above the horizon below 0.5 cd/klm.
- ✦ Maximum discretion criteria will be established for monument, public building and ornamental lighting. Luminaires should always be oriented downwards in order to meet the 0.5 cd/klm at and above the horizon plane criteria, restricting the luminous flux to the object to be illuminated. This type of lighting will be turned off during the Starlight Saving Time.
- ✦ Light trespass effects generated by outdoor luminaires should be strictly limited, using the full moon criterion.

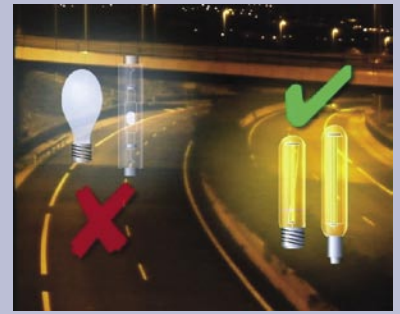
### Criteria for luminaires:

- ✦ The luminous flux emitted from a luminaire in the upper hemisphere should be zero (ULR=0), or an intensity at and above the horizon plane of 0.49 cd per each klm of flux escaping from the luminaire.
- ✦ To avoid harmful light emissions towards the horizon, the use of Full Cut-off (FCO) or CIE G6 luminaires is recommended.
- ✦ Luminaires should be generally installed without inclination, with the exception of the use of shields that will allow to meet the 0.5 cd/klm criteria in the installed position.
- ✦ Buffer zones should entirely comply also with the general recommendations on responsible and intelligent lighting contained in Chapter 8.
- ✦ Within the buffer zones a timeline should be established to retrofit the existing installations, following the above mentioned outdoor lighting criteria.
- ✦ In Astronomical Observation Sites, the least harmful option among the available technology should be used in outdoor lighting (which at present is represented by LPS/Low-pressure sodium lamps) <sup>16</sup>.



<sup>15</sup> Upward Light Ratio of the luminaire is the maximum permitted percentage of luminaire flux that goes directly into the sky. In other words, it is the proportion of output flux emitted from a luminaire at and above the horizon. It should not be confused with the flux emitted from the lamp.

<sup>16</sup> An emerging issue is LEDs (Light Emitting Diodes). They are highly energy-efficient, but at present only white LEDs are available for outdoor lighting, which emit a lot of blue light, that is bad for animals, humans, and astronomy. For this reason LED can be used only if its blue light is filtered out or not emitted at all.



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## External zone

When present, this corresponds to an area where existing larger human settlements or activities could negatively impact on the night sky quality of the Reserve.

Only the curvature of the Earth eliminates the effects of light pollution. Therefore, the size of the external zone would depend on the location of existing or potential major light emission sources which could affect the natural illumination conditions within the Starlight Reserve. In this zone, sustainable practices aiming to safeguard the night sky quality should be implemented, limiting to the maximum the effects of air and light pollution.

### Criteria

The external zone is considered as a responsibility area, where measures aiming to minimize light pollution are applied to respect the intrinsic values of the starlight reserve.

In these populated areas those lighting factors related to the loss of night sky quality or the protection of wildlife and landscapes would be taken into account, as well as those aspects directly or indirectly affecting the quality of life of population, such as obtrusive light into houses and recreational areas.

The recommendations contained in Chapter 8 dealing with responsible and intelligent lighting, are applicable in the external zones.

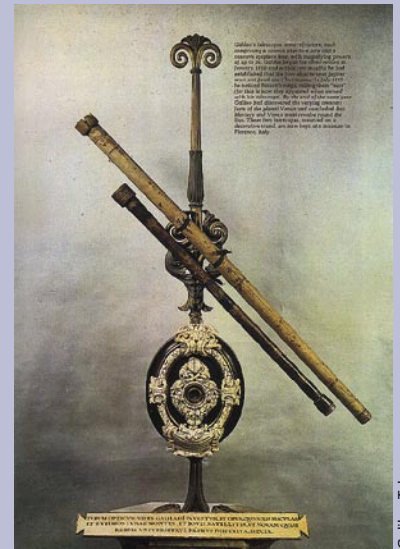
The same criteria of the buffer zone should be applied as an objective for new private and public installations in the external zones, to preserve the quality of the night sky within the Starlight Reserve.

### General criterion

Within a Starlight Reserve, the commitment for the defence of the night sky quality and the right to starlight should be supported by a public-private commitment that would be formally stated through laws, by-laws, resource management plans or public-private agreements, to effectively guarantee the implementation of the specific criteria for each zone.

## Necessary information and documentation to provide in the application process.

- ✧ Adoption of the Declaration in Defence of the Night Sky and the Right to Starlight (La Palma Declaration, 2007).
- ✧ Measuring of night sky quality.
- ✧ Inventory of the astronomy-related cultural resources.
- ✧ Assessment of environmental sensitivity areas and correction of impacts (wildlife species, habitats and ecosystems).
- ✧ Special requirements corresponding to the different activities or resources which may motivate the application (astronomical observation, environmental protection, nocturnal landscapes defence, integrity of heritage properties, tourism, stargazing).
- ✧ Starlight-related natural and cultural values to be protected, in case of World Heritage Properties and Biosphere Reserves.
- ✧ Luminance and/or illuminance levels in lit areas (if applicable).
- ✧ Zoning proposal in accordance with the values to be protected and the Starlight Reserve functions. The existing zonation and possible adaptation will be taken into account (World Heritage Properties, Biosphere Reserves, protected areas).
- ✧ Proposed or existing lighting and energy related policies and bylaws.
- ✧ Proposed or existing air quality policies and bylaws.
- ✧ Inventory of existing luminaires.
- ✧ Statement of Compliance to the Lighting and Atmospheric Protocol.
- ✧ Proposed or existing local protection measures regarding night sky quality.
- ✧ Outline of the Action Plan, including the Public Outreach Plan (education).



Galileo Telescope

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# General recommendations on outdoor lighting

The following general recommendations for outdoor luminaires are established<sup>17</sup>. They are applicable throughout the Reserve, especially in populated areas or where some kind of activity is carried out. Night sky protection, rational use of energy, quality of life of local populations, as well as landscape and night wildlife protection are taken into account.

General recommendations are of course not valid when more restrictive criteria are established within core and buffer zones.

The following orientations and general criteria for outdoor lighting shall be taken into account:

- ✧ Illumination should be to the minimum practical level,
- ✧ The affected area of illumination should be as small as practical,
- ✧ The duration of the illumination should be as short as practical, and
- ✧ Illumination should minimize the amount of ultraviolet and blue emission in the light.

What is "practical" depends upon the specific facilities in the area and the technology available at that time.

## How to plan a responsible lighting system

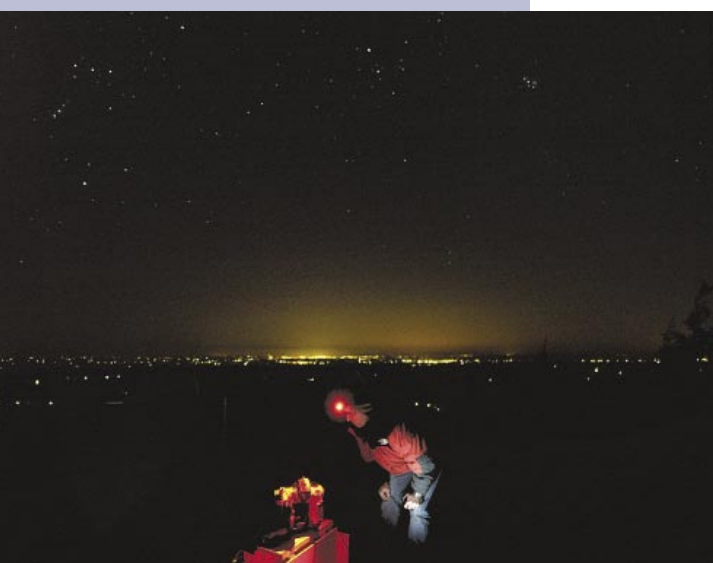
Before designing an intelligent lighting system responsible towards the quality of the night sky, or if we want to reverse the present effects of light pollution, we need to know:

- ✧ Where outdoor lighting is truly necessary and which useful service does it provide?<sup>18</sup>
- ✧ How much lighting the areas and object to be illuminated need?
- ✧ Which unwanted effects can outdoor lighting lead to? Benefits and impacts.

After the above questions have been answered, the following recommendations should be used as a guide:

## Prevent the emission of light towards the sky or the horizon

- ✧ For all new installations choose luminaires with no direct luminous flux directly to the sky. The selected luminaires should have an intensity of less than 0.49 cd/klm at and above the horizon plane.
- ✧ For road lighting, use luminaires with reflectors and transparent, preferably flat or shallow bowl glass closing.
  - ✧ When choosing roadway luminaires, the proportion of light emitted along the street side of the road should be maximized and the proportion emitted on the house side minimized.
  - ✧ For Sports lighting, if possible use only "double-asymmetrical" luminaires that can be mounted with their front glass horizontal, and avoid directing any other type of luminaires at angles greater than 70° (maximum intensity direction), to prevent direct glare and light trespass, provided that the 0.49 cd/klm parameter is fulfilled.



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<sup>17</sup> These recommendations are based on the study developed by the OTPC (Oficina Técnica de Protección del Cielo) of IAC (Instituto de Astrofísica de Canarias), on the Lombardy law n.17/2000, on several other Italian regional laws and on the Slovenia law.

<sup>18</sup> A simple generic reference to "security" or "people's enjoyment" reasons is not sufficient. Scientific criteria should prevail on subjective, non-demonstrated ones.

## Ensure all artificial lighting installations are designed to the lighting needs and minimise obtrusive light and energy use.

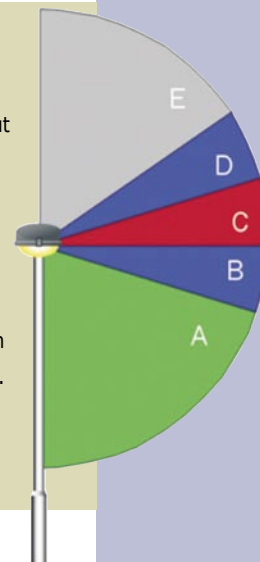
- ✧ Regulations, national laws, recognised international directives, and recommendations of International Commission on Illumination (CIE) aiming to prevent light pollution effects should be followed. Responsible manufacturer's or prestigious institution's published recommendations are valid for cases not included in these regulations. In all cases the minimum level figures set by any of the above mentioned regulations and recommendations should be considered as a target.
- ✧ Promote the reduction of lighting levels or even light turn-off at a certain hour at night in accordance with its usefulness.
- ✧ Use double asymmetric luminaires whose light beam is adapted to the surface to be illuminated, to illuminate only the needed area, and whose design has a high coefficient of utilization ( $K > 0,3$ ).
- ✧ Within urban areas consider adopting a lighting Masterplan in order to avoid the domino effect, which leads to lighting in excess only because the existing ones were over-illuminated. These existing over-illuminated areas should be corrected before designing new installations. Competition and the wish to stand out can exaggerate the lighting levels used, which lead to an uncontrolled and unnecessary escalation of the energy consumption.
- ✧ Do not design installations with exaggerated lighting levels in socially conflictive areas. There is enough information available demonstrating that security and over-illumination do not go hand by hand.
- ✧ Light pollution has increasingly become a major concern as an environmental impact mainly due to poorly designed outdoor lighting. Therefore, the enforcement of responsible lighting criteria should in this respect be maximised in these areas.



### Effect on Skyglow and cut-off angle<sup>19</sup>

Diagram to show relative impact of a luminaire's output contribution to skyglow.

- E 120-180° Critical area for skyglow experience from within urban and all areas but proportionally less impact to rural areas, distant from main light sources.
- D 95-120° Significant contributor to skyglow, especially in rural areas. Less likely to be obstructed.
- C 90-95° Critical zone for skyglow and obtrusion seen at 10s of km (in rural areas) where it is strongly dependent on aerosol scattering.
- B 85-90° Significant contributor to skyglow seen at a distance through reflection but reflected light more likely to be obstructed by buildings, trees and topography. Produce also glare in the roadway users.
- B<sub>bis</sub> 75° to 85° Produce glare in the roadway users.
- A 0-75° Ideal light distribution.



## Save energy and protect the environment

- ✧ Always choose the most energy-efficient lamps, that have an environmentally friendly spectrum, with none or very low UV and blue emissions.
- ✧ When the chromatic performance of an installation is not a major objective, use the bulb/luminaire assembly that gives the most efficient illumination in terms of  $W/m^2/lux$ .

<sup>19</sup> Chris Baddiley. British astronomical Association - Campaign for Dark Skies, Fabio Falchi, STIL.



- ✧ Choose lamps whose spectrum has the lowest impact on sky glow and on night sky quality in general. Reflection of air borne particles and scattering by the atmosphere make artificial light visible in the sky. Since the shorter blue wavelengths are more strongly scattered than the longer red wavelengths, white light is the most harmful for night sky quality. Yellow light is more scattered than red light but less than blue light. The most effective way available at present to reduce this negative impact is the use of monochromatic or quasi-monochromatic light sources, such as low-pressure sodium lamps (LPS). However, while these lamps emit a very narrow spectral band, almost a line, in the yellow part of the spectrum, they give no colour rendition and therefore may be unacceptable in many situations. High Pressure Sodium lamps offer a good compromise, combining an acceptable colour rendition to very low blue emission.
- ✧ Avoid the use of lamps emitting a large amount of ultraviolet radiation. This type of lamp attracts up to three times more insects than other types of lamps, leading to an important loss in biodiversity whose effects can reach 1 km distance. Negative repercussions of ultraviolet radiation on human health are also well known. As a general criterion, lamps emitting below 480 nm should be avoided.

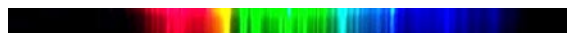
#### Types of light bulbs – Chromatic characteristics and efficacy

Type of lamp	Colour	luminous efficacy (lumen / W)
Low-pressure sodium (LPS)	yellow	180 - >200
High-pressure sodium (HPS)	rose / amber yellow - white	90 - 130
Metal halide (MH)	cool white / warm white	60 -120
Compact fluorescent (CFL)	white	45 -60
LED (light-emitting diode)	all colours	30-80
Mercury vapour (MV)	greenish blue / white	13 - 48
Incandescent/ Halogen	yellow/white	8 - 25

Spectrum of a low-pressure sodium lamp



Spectrum of a high-pressure mercury lamp



#### Recommendations on the limitation of intrusive light

Recommendations contained in the "Guide on the limitation of the effects of obtrusive light from outdoor lighting installations" (CIE 150:2003) can be considered as a reference, in particular those approaching the parameters of illuminance and luminous intensity emitted by luminaires, with regard to reserve zoning (E1 in sensitive areas of the Reserve<sup>20</sup>, and, in the rest of the reserve, E1 after curfew). In any case, the full moon criterion is the best recommendation and objective to pursue to reduce intrusive light.

#### Lighting of roads for motor and pedestrian traffic

- ✧ "Recommendations for the lighting of roads for motor and pedestrian traffic" (CIE 115-1995), which establish minimum values of luminance, are applicable. These minimum values should not be exceeded by more than 10%.



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<sup>20</sup> E1: Intrinsically dark landscapes: national parks, areas of outstanding natural beauty, surroundings of observatories, etc.



- ✧ The “Guide to the lighting of urban areas” CIE-136-2000 includes recommendations to limit luminaire brightness to avoid glare, setting maximum values according to the luminaire fixture height.

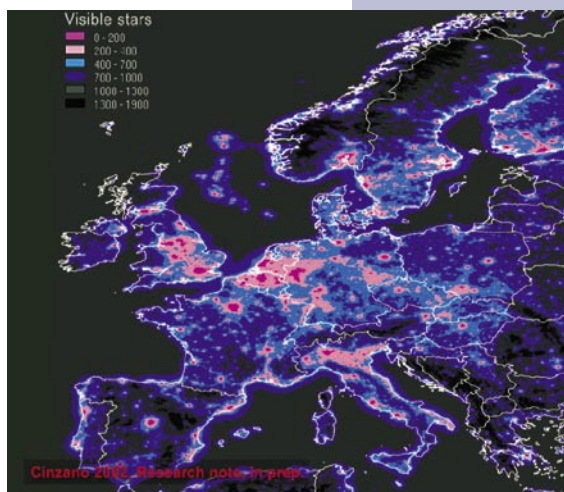
### Recommended illuminance levels for luminous signs and advertisements

The recommendations contained in the “Guide on the limitation of the effects of obtrusive light from outdoor lighting installations” (CIE 150-2003) related to this section can be taken into account as guidance reference. Advertisement luminous signs and billboards not exceeding a luminance value of 4 cd/m<sup>2</sup> and a total flux of 5000 lumen in every direction, turned off at the closure of the respective activity can be considered acceptable.<sup>21</sup>

### Recommended levels for building façades and monuments

These are currently contained in the CIE Guide to Floodlighting (CIE 93-1993), which provides information on how to use exterior lighting for the decoration of the nighttime urban landscape.<sup>22</sup>

Building façades and monuments should have a maximum luminance of no more than 1 cd/m<sup>2</sup>. Buildings should not be illuminated from bottom up, except for historic buildings for which it is impossible to light them from above. In this last case, the light flux should be completely intercepted by the building facade.<sup>23</sup>



### Reference Guidelines

In order to develop detailed criteria and recommendations, the following reference guides shall be taken into account:

- ✧ Summary of recommendations for outdoor lighting installation and open enclosures (OTPC-IAC, Oficina Técnica de Protección del Cielo de Canarias). Reviewed in 2008.
- ✧ Summary of criteria to be followed for lighting installations which may have a negative effect on night sky quality. (OTPC-IAC, Oficina Técnica de Protección del Cielo de Canarias). Reviewed in 2008.

<sup>21</sup> A few advanced regulations establish a limit of 1 cd/m<sup>2</sup> of luminance for luminous signs, with a total lumen output for each sign of no more than 4500 lm.

<sup>22</sup> This Guide is currently being updated by CIE Technical Committee 5.24

<sup>23</sup> The need to limit maximum brightness values allowed for illumination of building façades and monuments has also been taken into account in the “Guide on the limitation of the effects of obtrusive light from outdoor lighting installations.” (CIE 150-2003).



CIE guides, as well as the above mentioned reference guides, have a certain degree of complexity, and their interpretation therefore requires an appropriate level of knowledge of the subject. The following, more user-friendly readings on the subject can be used by non-specialized public to complement their knowledge:

- ✧ Explanatory memorandum on the reduction of light pollution and energy saving regulations - Decision of Director General for Environment, Soil and Coast Defense n.14096 of 12 October 2006 (<http://cielobuio.org/cielobuio/lrer19/circularaer.pdf>).
- ✧ The five fundamental technical parameters for a eco-friendly illumination (CieloBuio) <http://cielobuio.org/Article1085.html>
- ✧ Guidelines for Outdoor Lighting in Dark Sky Preserves (RASC-DSP-GOL). Royal Astronomical Society of Canada. March 2008.
- ✧ IDA Outdoor Lighting Code Handbook and International Dark Sky Reserve Lighting Guidelines.

With reference to Urban Star Parks:

- ✧ Guidelines for Outdoor Lighting in Urban Star Parks (RASC-USP-GOL). Royal Astronomical Society of Canada. March 2008.

With regard to laws and by-laws, the following ones can be kept as reference, among the several existing ones:

- ✧ The Canary Islands Sky Act (*Ley del Cielo de Canarias*, 1992), aimed to protect sky quality for astronomical observatories in the Canary Islands.
- ✧ Lombardy regional law n. 17/2000 and its integrations and modification.
- ✧ Slovenia's Decree on Limit Values due to Light Pollution of Environment (U.I. RS 81/2007).



The participants in the International Conference in Defence of the Quality of the Night Sky and the Right to Observe the Stars, meeting in La Palma, Canary Islands, Spain, on the 19th and 20th of April 2007, jointly with the representatives of UNESCO, UNWTO, IAU, UNEP-CMS, CIE, SCBD, MaB, EC and Ramsar Convention,

*Aware* that a view of the starlight has been and is an inspiration for all humankind, that its observation has represented an essential element in the development of all cultures and civilizations, and that throughout history, the contemplation of the firmament has sustained many of the scientific and technical developments that define progress;

*Guided* by the principles announced in the preamble of the Explanatory Note concerning the Proclamation of 2009 as International Year of Astronomy (33<sup>rd</sup> session of the UNESCO General Conference) that defines the sky as a common and universal heritage and an integral part of the environment perceived by humankind;

*Recalling* that humankind has always observed the sky either to interpret it or to understand the physical laws which govern the universe, and that the interest in astronomy has had profound implications for science, philosophy, culture, and our general conception of the universe;

*Recognizing* that the quality of the night sky, and thus the capacity to access the light of stars and other celestial bodies within the universe, is deteriorating at an alarming rate in several areas, that its contemplation is increasingly difficult, and that this process faces mankind with the generalized loss of a cultural, scientific, and natural resource with unforeseeable consequences;

*Conscious* that the deterioration of the clarity of the night space has started to emerge as a serious barrier to the continuity of astronomic observations, a branch of science that presently provides a flow of direct and indirect benefits which are increasingly valued;

Bearing in mind that the Rio Conference of 1992 proclaimed the necessary defence of the "integral and interdependent nature of the Earth", and that this protection naturally includes the dimension of the night skies and the quality of the atmosphere;

*Acknowledging* that the Universal Declaration of Human Rights of Future Generations states that persons belonging to future generations have the right to an uncontaminated and undamaged Earth, with untainted skies, and are entitled to enjoy these as the basis of human history of culture and social bonds making each generation and individual a member of one human family;

*Mindful* of the validity of the Universal Declaration of Human Rights, adopted by the General Assembly of the United Nations, and of the different international declarations on sustainable development and the conventions and protocols concerning the environment — all these safeguarding cultural diversity, biological diversity, the landscape, and thus the conservation of cultural heritage and combating climate change, which together have a direct or indirect influence on the need to safeguard the clarity of the night skies;

*Considering* that the scientific, cultural, educational, environmental, safety, and energy benefits of preserving a dark night sky need urgent attention and action;

*Attentive* to the urgent need to establish efficient alliances among the leading players, whose decisions can have an influence on reversing the

# Declaration in Defence of the Night Sky and the Right to Starlight



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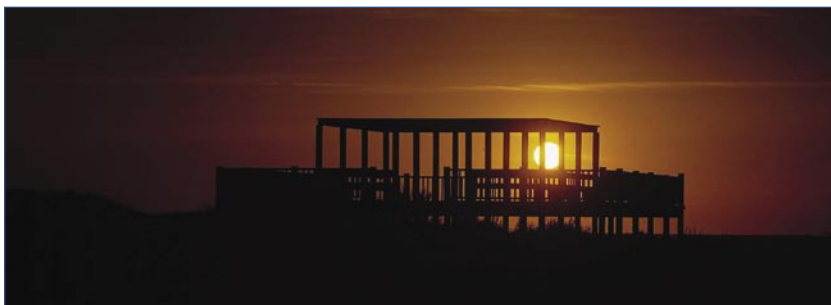
process of degradation affecting the quality of the night sky, with a view to providing all the possible assistance needed to protect and conserve the cultural and natural heritage of Starlight;

*APPEAL* to the International Community, and, in particular, URGE governments, other authorities and public institutions, decisionmakers, planners and professionals, private institutions and associations concerned, the world of science and of culture, and all citizens individually, to adopt the following principles and objectives of this declaration:

- 1 An unpolluted night sky that allows the enjoyment and contemplation of the firmament should be considered an inalienable right of humankind equivalent to all other environmental, social, and cultural rights, due to its impact on the development of all peoples and on the conservation of biodiversity.
- 2 The progressive degradation of the night sky must be considered an imminent risk that must be faced, in the same fashion that the main problems concerning resources and the environment are addressed.
- 3 The conservation, protection, and revaluation of the natural and cultural heritage associated with nocturnal landscapes and the observation of the firmament represents a prime opportunity and a universal obligation for cooperation in safeguarding the quality of life. For all decisionmakers, this attitude implies a genuine challenge involving cultural, technological, and scientific innovation, requiring a major constant effort to enable everyone to rediscover the presence of the night sky as a living part of the heritage of mankind.
- 4 Access to knowledge, armed with education, is the key to allow the integration of science into our present culture, contributing to the advance of humankind. The dissemination of astronomy and the scientific and cultural values associated with the contemplation of the universe should be considered as basic contents to be included in educational activities, which require a clear and unpolluted sky and proper training of educators in these subjects.
- 5 The negative effects of emissions and of the increased intrusion of artificial light on the atmospheric quality of nocturnal skies in protected areas have an impact on several species, habitats, and ecosystems. Control of obtrusive light must be a basic element of nature conservation policies and should be implemented in the management plans of the different types of protected areas to fulfil their mission in protecting nature and biological diversity.

- 6 Mindful that a starry night sky forms an integral part of the landscape perceived by the inhabitants of every territory, including urban areas, the landscape policies established in the different juridical systems need to adopt the pertinent standards for preserving the quality of the night skyscape, thus allowing them to guarantee the common right to contemplate the firmament.
- 7 The intelligent use of artificial lighting that minimises sky glow and avoids obtrusive visual impact on both humans and wildlife has to be promoted. Public administrations, the lighting industry, and decision-makers should also ensure that all users of artificial light do so responsibly as part of an integral part of planning and energy sustainability policies, which should be supported by light pollution measuring, both from the ground and from space. This strategy would involve a more efficient use of energy so as to meet the wider commitments made on climate change, and for the protection of the environment.
- 8 Areas suitable for unimpaired astronomic observation constitute an asset in short supply on our planet, and their conservation represents a minimum effort in comparison with the benefits they contribute to our know-how and to scientific and technological development. The protection of sky quality in these singular places must be given priority in regional, national, and international scientific and environmental policies. The measures and provisions must be made to safeguard clear skies and to protect such spaces from the harmful effects of light, radio-electric emissions, and air pollution.
- 9 Among others, tourism can become a major instrument for a new alliance in defence of the quality of the nocturnal skyscape. Responsible tourism can and should take on board the night sky as a resource to protect and value in all destinations. Generating new tourist products based on the observation of the firmament and the phenomena of the night, opens up unsuspected possibilities for cooperation among tourism stakeholders, local communities, and scientific institutions.
- 10 Sites included in the World Network of Biosphere Reserves, Ramsar Wetlands, World Heritage Sites, National Parks, and all those protected areas which combine exceptional landscape and natural values relying on the quality of their night sky, are called to include the protection of clear night skies as a key factor strengthening their mission in conserving nature.

All the necessary measures should be implemented to inform and to raise awareness among all the main actors involved in protecting the night environment —be it at local, national, regional, or international level— of the contents and the objectives of the International Conference in Defence of the Quality of the Night Sky and the Right to Observe the Stars, held on the Island of La Palma.



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# Glossary

## Units and acronyms

**candela [cd]** - is the SI base unit of luminous intensity. Power emitted by a light source in a particular direction (solid angle).

**lumen [lm]** - is the SI unit of luminous flux, a measure of the perceived power of light, used to describe a quantity of light emitted by a source or received by a surface.

**lux [lx]** - is the SI unit of illuminance and luminous emittance.  $1 \text{ lx} = 1 \text{ lumen/m}^2$ .

**SI** - International System of Units.

**ULR** - Upward Light Ratio of the luminaire is the maximum permitted percentage of luminaire total output flux that goes directly into the sky. It should not be confused with the flux emitted by the lamp.

## Concepts

**Starlight Savings Time** - The time after which stricter requirements (for the control of obtrusive light) will apply; often a condition of use of lighting applied by the local planning authority.

**Glare** - Glare is often the result of excessive contrast between bright and dark areas in the field of view.

**Illumination** - The application of visible radiation, or light, to an object.

**Illuminance** - (or illumination level) is defined as the amount of light being transmitted upon a certain area. The unit for illuminance is the lux, which is equal to one lumen per square meter [ $\text{lm/m}^2$ ].

**Light noise** - Light that does not transmit significant visual information.

**Light pollution** - Alteration of the natural night light levels due to manmade light.

**Lightscape** - The total environment created with natural and/or artificial light.

**Luminance** - Luminance is the brightness of an object that has been illuminated by a source [ $\text{cd/m}^2$ ].

**Luminaire** - An apparatus which controls the distribution of light given by a lamp or lamps and which includes all the components necessary for fixing and protecting the lamps and for connecting them to the power supply. Colloquially a 'lighting fitting'.

**Luminous efficacy** - The ratio of light emitted, to the power consumed by a lamp. [ $\text{lm/W}$ ].

**Nightscape** - A nocturnal scene considered together with all the elements and features constituting it.

**Obtrusive Light** - Spill light which because of quantitative, directional or spectral attributes in a given context, gives rise to annoyance, discomfort, distraction or a reduction in the ability to see essential information.

**Over-illumination** - excessive use of light. Presence of lighting intensity (illuminance) beyond that required for a specified activity.

**Photopollution** - Alteration of natural light regimes.

**Sky glow** - Sky glow is caused by light that shines upward and is scattered off dust and aerosols in the lower few kilometres of our atmosphere. It is seen at a great distance as the dome of light over urban areas.

**Skyscape** - A view, landscape or representation of the sky.

**Utilization Factor** - The proportion of luminous flux emitted by a lamp which reaches the working plane (should be  $> 0.3$ ).

**Utilance** - The proportion of luminous flux emitted by a luminaire which reaches the working plane (should be  $> 0.4$ ).





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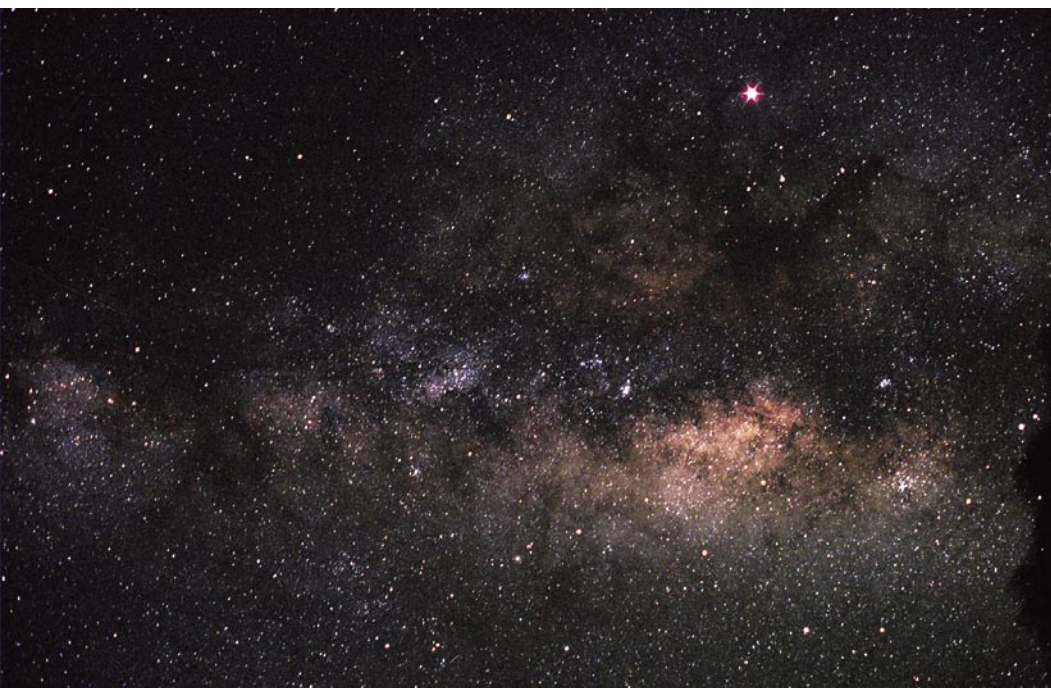
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Cerro Tololo Observatory



The starry sky over La Palma on April 20<sup>th</sup>, 2007, the night when the Starlight Declaration was adopted.  
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## Starlight Reserves and World Heritage Working Group

This document has been reviewed during the International Workshop and Expert Meeting Starlight Reserves and World Heritage. The overall aim of this meeting was to discuss the problems of identification of specific categories of natural sites, skylscapes, cultural nightscapes, and exceptional sites for astronomical observation, as "Starlight Reserves" for their possible nominations on the World Heritage List.

The International Workshop and Expert Meeting "Starlight Reserves and World Heritage – scientific cultural and environmental values", held in Fuerteventura, Spain, on 10-11 March 2009, was attended by participants and experts from 10 countries (Algeria, Belgium, Canada, France, Germany, Italy, Slovenia, Spain, UK, USA), representatives of private organizations, enterprises, tourism industry, NGOs, scientific bodies and research stations, as well as international organizations including UNWTO, the International Astronomical Union (IAU), and the UNESCO MAB Programme and the UNESCO World Heritage Centre .

In the meeting's final report, the following recommendations regarding the Starlight Reserves guidelines were established, among others:

- ✧ Light at night is useful for many human activities; however wasteful and unnecessary light can and should be reduced through best management practices. The meeting considered that *light pollution is the introduction by humans, directly or indirectly, of artificial light into the environment.*
- ✧ The requirements and orientations contained in the "Starlight Reserve Concept" document (March 2009) as guidance for those World Heritage properties and other protected areas that include astronomical values should be adopted and implemented.
- ✧ Tourism would be an excellent opportunity to promote the Starlight Reserves. The meeting recommended that a framework towards Starlight certification devising voluntary standards be prepared including scientific inputs, inputs from the tourism industry and from destinations. UNWTO and UNESCO would provide the institutional support for the operation of such a scientific and tourism quality system.
- ✧ The climate change context should be used to link the Starlight initiative to the promotion of energy efficient and intelligent lighting opportunities in urban, rural and remote areas. In particular to encourage urban administrators to develop educational and recreational products around the Starlight and dark skies phenomena that could be of public and economic interest. The expert meeting suggested exploring the feasibility of including the Starlight Reserve concept in MAB urban ecology and World Heritage cities programmes (including approaching the World Heritage cities organization - WHCO) at UNESCO.

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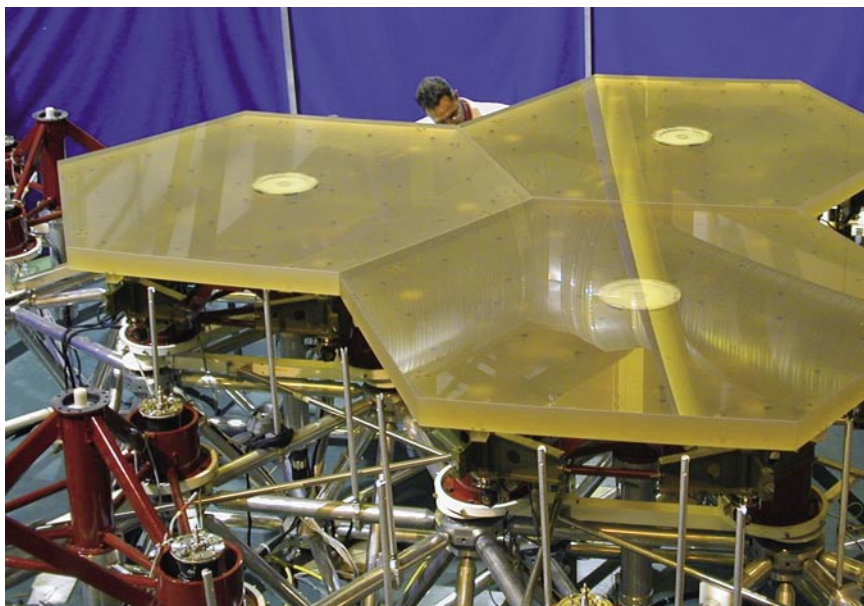
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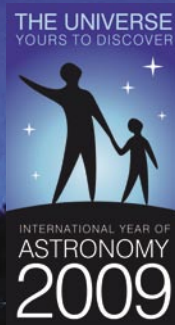
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[www.starlight2009.net](http://www.starlight2009.net)