New Zealand

Starlight Conference

Church of the Good Shepherd, Lake Tekapo. Photo Fraser Gunn

Book of Abstracts

Lake Tekapo

20 – 23 October 2019

Starlight Conference Organizing Committee

- John Hearnshaw — University of Canterbury, Christchurch (co-chair)
- Nalayini Davies — Auckland Astronomical Society; Astronz, Auckland (co-chair)
- Margaret Austin — Christchurch
- Steve Butler — Royal Astronomical Society of NZ, Dark Skies Group, Invercargill
- Bruce Mincham — Twizel (treasurer)
- Kaye Paardekooper — Pukaki Observatory, Lake Pukaki, near Twizel
- Lydia Stoddart — Ngai Tahu Tourism, Christchurch

Starlight Conference Abstracts

Keynote invited speakers are indicated by (✶)

Session 1: Dark sky places and the global scene

Ruskin Hartley, Executive Director of the International Dark Sky Association, Tucson Arizona, USA (✶)

Towards a Dark Sky World

Earlier this year, I joined the team at the International Dark-Sky Association to lead our work to protect the night from light pollution. Despite working in conservation leadership roles for more than twenty years, I was new to the field. I did not appreciate that light pollution is a major environmental threat that can disrupt wildlife, impact human health, waste money and energy, contribute to climate change, and block our view of the universe. As I have come to learn, unfortunately, my experience is the norm. Despite notable successes in protecting dark sky places around the world, globally light pollution continues to grow at twice the rate of population growth. As a movement, how can we turn this around? How are we going to build a unity of purpose around the value of natural darkness and move from protecting existing dark sky places, such as those certified through our International Dark Sky Places program, to restoring dark skies around the world? I will review some recent successes from around the world, examine the opportunities in New Zealand to advance the concept of a Dark Sky Nation, and share a preview of IDAs new strategic priorities to address light pollution in the coming years.

Adam Dalton, International Dark Sky Places Program Manager, IDA, Tucson Arizona, USA

International Dark Sky Places and New Zealand: Status Report

Since the establishment of the Aoraki Mackenzie International Dark Sky Reserve (IDSR) in 2012, New Zealand has transformed to become a leader in the worldwide fight against light pollution. As of 2019, three designated International Dark Sky Places (IDSPs) in New Zealand total 6,402 km^2, roughly equivalent to the size of the country of Brunei. Aside from previous IDSP designations, there are many sites in the country which are currently actively seeking and pursuing diverse IDSP designations such as: Parks, Communities, Reserves, etc. Thereby, potentially priming New Zealand to remain a dark skies leader for years to come.

In the following presentation, the International Dark Sky Places Program Manager, Adam Dalton, will present relevant and informed updates pertaining to the state of New Zealand's IDSPs. Following, future action items related to the International Dark Sky Places Program within the context of New Zealand will be discussed.

Robert Dick, CEO at the Canadian Lighting Company, Ontario, Canada

The Canadian Dark-Sky Preserve Program, Royal Astronomical Society of Canada

The Canadian Dark-Sky Preserve Program is primarily to promote and preserve the nocturnal environment. Consequently, the main requirement is a lighting guideline that has come to define lighting with low ecological impact. Initially adhering to these guidelines required the modification of existing luminaires that may have fallen short of full compliance. New techniques have been developed that simplify the conversion. And as more versatile light fixtures become available, compliance has become much easier. This presentation will outline "low-impact" lighting, how to convert existing light fixtures and the demonstration of a fully compliant luminaire.

Pedro Sanhouza, Office for the Protection of the Night Sky of Northern Chile (OPCC)
(with Guillermo Damke, Universidad de La Serena/AURA Inc. Chile, Rodolfo Angeloni, Universidad de La Serena, Chile, Miguel Martínez, OPCC, Chile, Hugo Rojas, OPCC, Chile)

Protecting the Night Sky of Northern Chile: A Proposal to Restrict Spectral Emissions in the Era of LED

Currently, in the Northern Chile, most of the outdoor lighting uses High Pressure Sodium (HPS) technology. Nevertheless, fixtures are being replaced with Lighting Emitting Diode (LED) lamps. Unfortunately, industries and municipalities usually prefer to increase the lighting levels instead of getting a better uniformity by reducing the levels of illumination. Furthermore, cold LED is currently the more common illumination choice instead of the warm or amber versions, even when these versions are competitive in terms of efficiency. Apart from that, the population is still growing with an additional increase of migration levels, concentrating the population in big cities in the vicinity of the large optical astronomic observatories.

Based on this reality, our efforts are being focused on modifying the Chilean legislation on light pollution to restrict the spectral emission of lamps and also to increase the protection near observatories. Our current legislation, the Supreme Decree N043/2012 Ministry of Environment (MMA), allows a 15% of emission of light in the range 300-379nm, a 15% in the range 380-499nm, and a 50% from 780nm to 1000nm, all these emissions considered with respect to the visible spectral range from 380-780nm. Now, as Office for the Protection of the Night Sky of Northern Chile (OPCC) a joint venture among AURA, CARSO, ESO, and GMT, in agreement with the ministries of Environment and Foreign Affairs and the Chilean Society of Astronomy, we propose the following spectral emission restriction in a radius of 100km around the observatories of Cerro Tololo and Cerro Pachon; La Silla and Las Campanas Observatories; and, Cerro Paranal and Armazones observatories: an emission from 300-379nm and form 380-499nm of 1% in respect of the visible, and from 780-1000nm of 10%.

Pedro Sanhueza, OPCC. AURA CARSO ESO GMT, Chile
psanhueza@opcc.cl; psanhueza2007@gmail.com

Session 2: Dark sky places and the global scene: dark sky places in New Zealand

Antonia Varela Perez, Director of the Starlight Foundation, Institute of Astrophysics of the Canary Islands, Tenerife, Spain (✶)

The Starlight Foundation: 12 years of commitment with the Starlight Declaration

Starlight principles and recommendations are brought together in the "Declaration in Defence of the Night Sky and the Right to Starlight" ("La Palma or Starlight Declaration." 2007), in which, in addition to the IAC, representatives of UNESCO, UNWTO, IAU, UNEP-CMS, CE, SCBD, COE, MAB and the Ramsar Convention all participated and launched Starlight as an international movement in defence of the sky by night and day and to treat it as a source of knowledge and culture that should be shared with society as a whole, promoting the dissemination of astronomy and sustainable, high-quality tourism in those places where the night sky is cared. The Starlight Reserves, Tourist Destinations and other modalities are scenarios that incorporate the preservation and observation of the sky as part of the natural, scenic, cultural and scientific heritage and encourage "Star Tourism", promoting infrastructure, products, activities and training of specialized guides in the field of sustainable tourism. The Starlight Foundation has been selected to lead the UNWTO Affiliate Member Working Group on Scientific Tourism. Updated Starlight certifications and current projects will be summarized in this presentation.

John Hearnshaw, Chair of the Aoraki Mackenzie International Dark Sky Reserve board, and University of Canterbury, Christchurch, New Zealand

Dark skies in the Mackenzie – the Aoraki Mackenzie International Dark Sky Reserve

The Aoraki Mackenzie International Dark Sky Reserve was the first dark sky place in New Zealand recognized by IDA. It was created in 2012 and announced at our last Starlight Conference in June 2012. The reserve covers 4367 sq km of the Mackenzie Basin and all of Aoraki/Mt Cook National Park. It was accorded gold tier status by IDA in 2012, the first such reserve to be created at this tier. There are three small centres of population in the reserve, namely Lake Tekapo, Twizel and Mt Cook Village. The reserve is run as a charity with a board of about 12 individuals. The board runs public outreach events, including lectures, festivals and also this conference. The board of the reserve is active giving advice on good lighting practices to minimize light pollution.

Richard Somerville-Ryan, Great Barrier Island – Aotea

Protecting Beyond the Back of Beyond - The Great Barrier Island International Dark Sky Sanctuary

Amie Young, Tourism Product Development Advisor, Great South
Dark South – The Stewart Island/ Rakiura International Dark Sky Sanctuary Journey

Amie Young of Great South will share the journey taken by Stewart Island Rakiura to become an internationally recognised Dark Sky Sanctuary. Now the southernmost Dark Sky Place in the world, key aspects that supported Rakiura's successful accreditation will be shared as well as insights gained throughout the process and aspirations for the future of dark skies on the island.

David Welch, Chair of the IUCN Dark Skies Advisory Group, Ottawa, Ontario, Canada

Dark Sky Places of the World: The evolution of the dark sky place idea, and where it's at today (presented by Robert Dick)

Session 3: Best lighting practices for dark sky places; astro-tourism

Richard Wainscoat, Institute of Astronomy, University of Hawaii, Honolulu, HI, USA (✶)

Preserving the dark night sky at observatories in the era of LED lighting

Astronomy has benefited for many years from the orange color of sodium lighting. Sodium lighting is deficient in blue light, so Rayleigh scattering is lower; low-pressure sodium light is almost monochromatic, so is an ideal light source for use near to observatories. Advances in energy efficiency of Light Emitting Diodes (LEDs) over the last 10 years is resulting in large scale lighting replacements, and has led to the demise of low-pressure sodium lighting. LEDs provide a one-time opportunity to replace poorly shielded lights with fully-shielded lights (which is very beneficial to dark-sky preservation). However, white LEDs have much more blue light than the sodium lights that they replace. As a result, LED light reflected from the ground is a major concern due to increased Rayleigh scattering. The techniques that are being used to preserve the dark night sky around Maunakea and other major observatories will be discussed.

Mike Geddis, EnergyLight, Christchurch

The Dark Sky - Light Pollution and how to reduce it

Dark Sky requires that lighting design for outdoor areas is approached in a way where minimizing and if possible, eliminating light pollution is of the highest importance. If this is applied, unnecessary light pollution is avoided for people, and observation of the night sky is enhanced. This approach requires an effective design concept with a luminaire technology tailored to suit.

Lara and David Mitchell, Lumican, Edmonton, Alberta, Canada

Responsible lighting choices and the undeniable data

The talk will be very little about my technology at Lumican, but more about what information municipalities are missing and what the future looks like if we don't start making the right choices in lighting now.

Marnie Ogg, Sydney, Australia - Australasian Dark Sky Alliance

Dark Skies, a movement around the globe.

Councils, tourism groups, schools, mums and dads are all lifting their eyes to the night sky. Light pollution is finally on the radar in the southern hemisphere, and the grassroots movement is growing. As the media start to pick up this conversation, we need a clear global message and a strategy that sees us standing as united leaders of this new regime.

What is working, what is not, and how can we provide one voice, rather than a series of whispers?

Megan Miller, Mackenzie Region Trade & Media Marketing Executive, ChristchurchNZ and

Jason Menard, Mackenzie Region Digital Marketing Executive, ChristchurchNZ

Experiencing the Night Sky: Astro-Tourism, Travel Trends and the Visitor Economy

For decades the Mackenzie Region has been at the forefront of astronomical research, astro-tourism and dark sky preservation in New Zealand.

The establishment of the University of Canterbury Mount John Observatory in Takapō/Tekapo in the 1960s, the founding of the Dark Sky Project (formerly Earth & Sky Stargazing) astro-tourism experience in 2004, and the formation of the Aoraki Mackenzie International Dark Sky Reserve in 2012 laid the foundation for what has become a major pillar of the region's brand identity and visitor economy.

Visitor numbers to the Mackenzie have reached approximately 1 million guest nights each year, and many of those visitors participate in at least one of the region's night sky

experiences. Astro-tourism is the Mackenzie's single largest area of new product development, with operators offering a wide range of outdoor stargazing, virtual astro-tourism experiences and stargazing-themed accommodation.

Interest in astro-tourism continues to grow in key global visitor markets. Publications such as Lonely Planet have flagged astro-tourism as one of the major international travel trends. The Mackenzie Region and its operators are uniquely positioned to lead New Zealand, and the world, in the growth and development of this industry.

Session 4: Dark sky places and World Heritage; dark sky protection in other countries

Clive Ruggles, University of Leicester, UK

Astronomical World Heritage and dark skies—an update

Two very different astronomical properties were inscribed onto UNESCO's World Heritage List this year—Jodrell Bank Observatory in the UK and Risco Cáido and the Sacred Mountains of Gran Canaria in Spain—and more are set to follow. This represents a major milestone for the UNESCO-IAU Astronomy and World Heritage Thematic Initiative (AWHI).

A particularly tricky issue, tackled in some detail by the AWHI, is the recognition and protection of dark skies. Dark sky areas cannot in themselves be considered as potential World Heritage Sites, primarily because a dark sky indicates a lack of light pollution rather than representing something tangible residing within the territory of a particular country. On the other hand there are a range of ways in which dark sky values can be interrelated with broader cultural or natural values of a place and thereby contribute to its overall cultural or natural value and potential "outstanding universal value", as required for WHL inscription.

All this increases the prospects that in the not-too-distant future we will see some dark sky places nominated for the WHL, provided that OUV can be demonstrated in other ways: the preservation of its dark skies would then become a key management issue for the new World Heritage Property.

In this paper I shall review those prospects, including the possible nomination of the Mackenzie Basin, perhaps as an extension of the existing WH site of Te Wahipounamu / South-west New Zealand.

Al and Annie Grauer, Cosmic Campground, New Mexico, USA

(with Nalayini and Gareth Davies, Auckland NZ)

Space Weather Animates the Natural Night Sky

The natural night sky is never without light. It is a constantly changing kaleidoscope of celestial and atmospheric sources of illumination animated by Space Weather. These statements are verified by night sky brightness data we collected at Cosmic Campground International Dark Sky Sanctuary (CCIDSS), USA and at Aotea/Great Barrier Island International Dark Sky Sanctuary (AGBIIDSS), New Zealand. These sites have artificial-light-pollution-free natural night skies. The equipment employed are identical Unihedron SQM-LU-DL meters, used as single channel differential photometers, to scan the sky as Earth rotates on its axis. We developed new analysis techniques which select those data points which are uninfluenced by Sun, Moon, or clouds to follow brightness changes at selected points on the celestial sphere and to measure the brightness of the airglow above its quiescent level. The 2018 natural night sky was measured to range from dark (Bortle 1, 21.7 to 22.0 mag/arcsec^2) to one with moderate light pollution (Bortle 4, 20.4 to 21.3 mag/arcsec^2) without human intervention. The celestial light curves (brightness versus Right Ascension) we observe are dominated by the Milky Way and Zodiacal Light. The modulations of these celestial light curves, are related in complex ways to elements of space weather conditions in the near Earth environment. In particular, episodes of increased night sky brightness are observed to be contemporaneous with geomagnetic activity, increases in mean solar wind speed, and some solar proton/electron fluence events. Charged particles in the solar wind take days to reach near Earth environment after a coronal hole is observed to be facing in our direction. Use of this information could make it possible to predict increases in Earth's natural night sky brightness several days in advance. Our initial research will be published in a scientific research paper “Impact of Space Weather on the Natural Night Sky” which has been accepted by the international astronomical journal, Publications of the Astronomical Society of the Pacific.

Junichi Watanabe, National Astronomical Observatory of Japan, Mitaka, Tokyo, Japan

The Japanese campaign-style government effort for protecting skies from light pollution.

Phil Langill, Rothney Astrophysical Observatory, University of Calgary, Alberta, Canada (with Suzanne Oel (Foothills County), Greg Shyba (ASCCA) & Roland Dechesne (RASC))

Keeping it Dark in the Country, a Success Story of Astronomical Proportions

The Rothney Astrophysical Observatory (RAO) is arguably the top University operated teaching and research observatory in Canada, in large part because it's situated under dark skies. But to the west is the type of picturesque scenery of rolling foothills and Rocky Mountains that makes developers drool. And to the east is Calgary, one of the fastest growing, urban sprawling monstrosities in Canada. It's a recipe for dark sky destruction. Yet over the past decade measurements show that the sky at night has not brightened over the RAO. In this talk I will describe how I believe this surprising fact is the result of some wonderful partnerships that have grown and flourished, rooted in the common goal of preserving dark skies, between the RAO, the municipal County of Foothills, the Ann & Sandy

Cross Conservation Area, and of course the Calgary Centre of the Royal Astronomical Society of Canada. Prospects for the future of the RAO will also be discussed.

Charlotte Harley, Elan Valley Trust, Powys, Wales, UK

Dark Skies of Wales

A quick insight into Wales's only Dark Sky Park (currently); the Elan Valley Estate. Plus, a glance at how we have been working with others; including dark skies developments with the Cambrian Mountains, working with other IDA sites such as the Brecon Beacons National Park to secure tourism outlets from Dark Skies, and how we are broadening our reach and working with Dark Sky New Zealand to provide northern and southern hemisphere perspectives on the night sky.

Public talk, evening of Monday October 21 at 7:30 pm

Victoria Campbell, Ngai Tahu Kotai Mano Kaika, Dunedin, Otago

Tātai whetū ki te raki – The myriad of stars, our constant connection

The journey of the Ngāi Tahu claim is a legacy that spans seven generations. It is a journey that was consumed by the quest for justice and the struggle to have the right to our place, to our knowledge, and to be who we are. The settlement has created space where we can celebrate not only the journey of the struggle but the blueprint at the foundation of our arrival here to these lands.

The legacy of our ancestors who navigated their way here to Te Waipounamu using their ancient and developed understanding of the celestial bodies and their patterns is embedded in our landscape and skyscape. The understanding of the skyscape provided a prehistorical framework that enabled the exploration and discovery of the largest ocean in the world and governed the human interaction of our tupuna with their environment.

I invite you to join me on a journey of a story untold for generations, that is once again taking shape and finding a voice in our dark skies. *Mō tātou, ā, mō kā uri ā muri ake nei* – for us and our children after us.

Session 5: Light pollution as a global environmental issue

Fabio Falchi, Istituto di Scienza e Tecnologia dell'Inquinamento Luminoso (Light Pollution Science and Technology Institute), 36016 Thiene, Italy (✶)

Light pollution: the good, the bad and the ugly (pre-recorded talk)

The light pollution mapping of the world atlas research group is illustrated after the pioneering efforts of Walker, Treanor and Berry in the ’70s of the last century. The first map obtained by Falchi in 1998 modelling the propagation of light detected by satellite paved the way towards the first World Atlas of Artificial Night Sky Brightness, published in 2001, using the Cinzano model. In 2016 the new world atlas takes advantage of the higher resolution and dynamic range of the Suomi NPP satellite, of the updated Cinzano mapping technique and of the calibration of 30,000 sky brightness measurements around the world.

Using the sky brightness dataset of the New World Atlas, along with population density and income data the group analysed all the US counties and European provinces, obtaining a global rank given by light pollution levels, artificial outdoor light flux per capita and artificial light flux per unit of income. In this rank Germany stands out as the absolute winner, having 17 of ‘the good’ out of the 25 best provinces in Europe. On the other end of the rank, Portugal and Italy have the highest number of ‘the bad and the ugly’ provinces. USA, per capita, pollutes three times as much as Europe, and five times more than Germany.

The discrepancies found may help the worst counties and provinces to find out why they pollute so much, compared to the good examples. Following the example of the most virtuous, a substantial reduction of light pollution is possible. Other help may arrive to adaptive lighting and even from the diffusion of autonomous cars that don’t need outdoor lighting to drive safely. Light can be so dimmed to be comfortable for pedestrians and not blind them while walking under light poles.

Chris Kyba, GFZ German research centre for Geosciences, Potsdam, Germany

The importance of visual observations of skyglow by amateurs (pre-recorded talk)

Ramotholo Sefako, South African Astronomical Observatory, Cape Town, South Africa

Sutherland Central Astronomy Advantage Area (SCAAA) Protection Regulations: Preserving Dark Skies at SAAO

The South African Astronomical Observatory (SAAO) observing station near Sutherland, Northern Cape Province (NCP), South Africa, is one of the darkest observatories in the world. It is home to many national and international optical and IR telescopes, including the Southern African Large Telescope (SALT), the largest optical telescope in the Southern Hemisphere. The whole NCP is declared as an Astronomy Advantage Area, and it is protected under the Astronomy Geographic Advantage Act of 2007, which empowers the Department of Science and Technology (DST) minister to restrict or prohibit activities that pose a threat to optical and/or radio astronomy. Recently (May 2019), the Sutherland Central Astronomy Advantage Area (SCAAA) regulations meant to protect optical astronomy and related endeavours within the SCAAA (75 km radius from SALT in the NCP) were promulgated. I will discuss these and the processes followed detailing how these regulations were set up, how they are to be implemented and the challenges we are likely to face. I will also discuss some of the main activities that may pose problems relating to

light and dust pollution, and our (SAAO) efforts, in partnership with Astronomy Management Authority within the DST, to protect the SAAO against light pollution, thereby contributing to preserving one of our most important natural resources in South Africa, dark skies.

Mike Chapman, SOLIS, Sydney, Australia

Mitigating obtrusive light on the night sky in regional areas

The recent programs to convert street lighting from the technologies of high intensity discharge lamps to light emitting diodes has seen a rush for local governments to reduce power consumption costs and carbon footprints. These programs driven by a direct involvement of government by way of funding programs based on carbon emissions. An outcome of these programs has seen a division in the community between astronomers, professional and amateur with the lighting industry, as well as division within the lighting community. The issues at conflict: the use of high correlated colour temperature, adequate colour rendering, ground uniformity, visual comfort, and visibility. Many jurisdictions in many countries regulate the issues in conflict with standards often based on CIE standards such as CIE-150 Obtrusive Lighting and may be supplemented with additional controls This standard has application in individual and specific situations but is not able to be applied to wide scale situations such as the total effect of a town or city.

The expected result of changing a street lighting inventory in terms of sky glow is not taken to account at the planning phase. Here a modelling system called Illumina will be used to model the regional town Tamworth, of New South Wales, Australia. This town with a current population 50,000 people is planned to become a town of 100,000 people. The impact of this in increased lighting with resulting sky glow will be significant. This study presents the results of modelling this town using various street lighting technologies and discusses the impact on the night sky and mitigation strategies that would limit impact on rural night skies.

Duncan Steel, Xerra Earth Observation Institute, 50 Centennial Avenue, Alexandra, 9320. Central Otago, NZ

Earth's artificial rings

In the past astronomers interested in distant stars and galaxies would refer to asteroids as being the 'vermin of the skies', because the sunlight reflected by the billions of asteroids with which we share the solar system could obscure faint deep-sky objects or be unwelcome additions to celestial photographs. These interplanetary vagabonds have in more recent decades been joined by space wanderers closer to home: artificial satellites in orbit around our planet. In essence, Earth has a set of man-made rings formed since the start of the Space Age sixty years ago, and now being rapidly bolstered.

The functioning satellites, expired payloads, cast-off rocket stages and myriad pieces of debris circuiting our planet pose a light pollution source that is quickly growing in density and complexity, posing problems to astronomers in various ways. For example:

a) Straightforward backscattering of sunlight (or indeed natural or artificial light from Earth) from the numerous items in orbit contribute to a noise background in long-exposure observations.
b) Incidental flares (intense specular reflections of sunlight lasting only seconds but reaching magnitude −8 on occasion) are well-known from the Iridium constellation, but various satellites designed specifically to produce such optical effects (such as the 'Humanity Star' launched from New Zealand in 2018 January) are exacerbating the problem.
c) The apparent angular speeds and directions of various asteroids in heliocentric orbit can be mimicked by artificial objects in geocentric orbit, leading to conflicts in the identification of slowly-moving light sources.
d) The effect of inter-satellite collisions or disintegrations of other origin is to increase the cross-sectional area per unit mass of such orbiting materials, enhancing both the amount of backscattered light and also the potential for the obscuration of celestial sources being studied by astronomers.
e) The dawn of the cubesat era twenty years ago has led to numerous launches of small satellites (though sometimes with solar cell arrays a metre or so wide) into low-Earth orbit, with up to a hundred cubesats being injected into low-Earth orbit (LEO) on single rockets.
f) Several constellations are now being planned containing thousands of small satellites in LEO so as to provide global wifi coverage.
g) In higher orbits, some satellite types can present consistent unwanted light sources in certain directions, the obvious example being geostationary satellites although there are other possibilities.
h) In medium orbits (above LEO at around 1,500 km but lower than geosynchronous altitude near 36,000 km) various satellite types such as Global Navigation Satellite System modules are being utilised over their functional lifetimes of perhaps a decade but then abandoned in orbits that are stable for many millennia.

In this paper I will review the core parameters of these various artificial rings of Earth in terms of the broad orbital types involved, the numbers and spatial densities they present, and the implications for the future of Earth-based astronomical observing.

Session 6: Blue light and its impact on human health and the environment

Sean Cain, Associate Professor of Sleep and Circadian Medicine, School of Psychological Sciences, Monash University, Melbourne, Vic, Australia (✶)

Light and Human Health

Light is a potent stimulus for human circadian, neuroendocrine and neurobehavioral regulation. In addition, light can restore human health in clinical applications such as

treating winter depression and selected sleep disorders. Light therapy also has been evaluated for healthy individuals who experience problems associated with shift work, jet travel, and space flight. Any agent that has the capacity to heal, however, also has the capacity to harm.

In 1987, it was hypothesized that the increased risk of breast cancer in industrialized countries is due, in part, to increased exposure to electrical light at night. That hypothesis was based on the idea that exposure to light at night would result in melatonin suppression that would, in turn, increase breast cancer risk. Since then, a number of epidemiological studies, have supported that components of that original hypothesis. Empirical evidence from both *in vivo* and *in vitro* animal and human studies also support this hypothesis. In 2010, the International Agency for Research on Cancer of the World Health Organization (WHO), published an extensive monograph concluding that shiftwork "that involves circadian disruption is probably carcinogenic to humans". Shiftwork nearly always involves exposures of workers to light during the nighttime hours. Subsequently, in 2012 and 2016, the American Medical Association (AMA) published policy statements on potential health hazards of light at night in general.

Alexander Tups, Centre for Neuroendocrinology and Brain Health Research Centre, Department of Physiology, School of Biomedical Sciences, University of Otago, Dunedin, New Zealand

The importance of the circadian clock and artificial lighting at the correct time for human metabolic health

Most living organisms rely on a synchronization between daily environmental alterations and their biologic processes for their survival. This is facilitated by a so called circadian clock, a master pace maker that in mammals including humans resides in the hypothalamus of the brain. For the clock to adjust these processes to the most beneficial time of day it requires to be entrained on a daily basis by cues such as light and melatonin, the hormone of the darkness. Rapidly growing evidence suggests that disrupting our natural rhythm which is brought about by light exposure at the wrong time may cause cancer, obesity, diabetes, depression, sleep disorders and possibly increase the risk for dementia. This can occur due to our modern lifestyle that may include shift-work (classified as a carcinogen in Denmark), frequent jet lag, social jet lag (the difference in the time we sleep during work and work-free days), or exposure to bright artificial light at the wrong time.

In two separate studies using mice, we established that disruptions of this circadian rhythm are detrimental for metabolic health. In the first study, we could show that frequent disruption of the circadian rhythm led to weight gain and severe diabetes symptoms. Furthermore, it led to profound changes in the brain to process hormones that regulate body weight and glucose levels.

The second study revealed that popular dieting strategies such as time restricted eating patterns, e.g. to restrict caloric intake to 8 hours a day, are dependent on the circadian timing. This means it is critical what meal to skip as this needs to be aligned with the best timing for our body to process food enriched in saturated fat. We found that the ability of

the brain to respond to the body weight regulatory hormone leptin varies throughout the day and it appears that eating patterns have to be aligned with the circadian rhythm to maintain a healthy metabolism.

Taken together rapidly growing evidence suggests that disruptions to the circadian rhythms are detrimental for human health. In light of these findings the rapid spread of bright LED lights requires to be treated with caution.

Xyra Xavia, Dunedin Dark Skies group

The importance of access to the night sky and the value of darkness and sleep

While the beauty of a starlit sky and the disappearance of darkness are widely acknowledged, what's less well known are the benefits that a starry vault and the dark bestow physically, emotionally and spiritually. Kyra delves into these mysteries, and explores too, the fascinating biological processes involved. Discover why we need dark nights, deep rest and star-studded skies for our long-term wellbeing, and how cultivating our connection with the heavens, and developing respect for the time between dusk and dawn can have a profoundly positive effect upon our quality of life. This thought-provoking talk promises to elevate, inspire and leave you with a sense of wonderment.

Alicia Dimovski, La Trobe University, Melbourne, Australia

The dark side of energy-efficient lighting: LED lights are giving wildlife the blues
Co-author: Kylie Robert, La Trobe University, Melbourne

In a bid to reach climate targets, and reduce our carbon footprint, we have begun implementing "sustainable lighting"; successfully reducing CO_2 emissions and saving costs, but an unexpected negative impact may be hiding in the dark. The introduction of energy-efficient light emitting diodes (LEDs) may be having a significant negative impact on the health of wildlife. Exposure to artificial light can result in a wide range of biological effects on animals including altered physiological signalling, circadian clock disruption and modified behaviour. However, one advantage of LED light sources compared to traditional lighting is the flexibility in spectral composition.

Regular LED lights exhibit bright white, short-wavelength light, the most potent suppressor of melatonin, a regulatory hormone released during the hours of darkness. We manipulated the spectral composition of LED lights as a means to mitigate the ecological and health consequences associated with their use. We experimentally investigated the impact of white LEDs (peak wavelength 448 nm), long wavelength shifted amber LEDs (peak wavelength 605 nm) and no lighting on melatonin production, lipid peroxidation and circulating antioxidant capacity in the tammar wallaby (Macropus eugenii). Night-time melatonin and oxidative status were determined at baseline (day 0) and again after 10 weeks' exposure to light treatments. White LED exposed wallabies had suppressed

nocturnal melatonin compared to no light and amber LED exposed wallabies, while there was no difference in lipid peroxidation and antioxidant capacity.

These results provide further evidence that short-wavelength light at night significantly suppresses nocturnal melatonin. Importantly, we also illustrate that shifting the spectral output to longer wavelengths could mitigate these negative effects. Findings from this research will be used to determine appropriate LED lighting to mitigate the ecological impacts on animals living in disturbed urban habitats, and ultimately support the development of guidelines for "Wildlife Friendly" lighting.

Session 7: Astrophotography and the beauty of the night sky; astronomy at Mt John Observatory and the University of Canterbury; dark sky protection in China

Babak Tafreshi, founder of The World at Night (http://twanight.org/newTWAN) Boston, Massachusetts, USA (✶)

The World at Night

Bridging science, art and culture by connecting the Earth & sky in photography. Babak Tafreshi spent the past two decades photographing surreal scenes of night sky in all continents, an adventurous journey to the world at night where the wonders of Earth & sky merge in photography.

This talk also presents The World at Night (TWAN) international program that involves many of the world's best nightscape photographers documenting the last remaining starry skies on the planet to increase public awareness on values of natural night environment for all species. TWAN is also a bridge between art, humanity, and science, with a unique message. The eternally peaceful sky looks the same above symbols of all nations and regions, attesting to the unified nature of Earth and mankind. One People, One Sky!

TWAN produce and present photographs and time-lapse videos of the world's landmarks against the celestial attractions. The familiar context of the images, which represent naked eye views, add a new tool to efforts to popularize astronomy alongside images and science results from large telescopes. The photos have been used by astronomy educators world-wide as they educate viewers on many fundamental aspects of practical astronomy such as the natural look of sky, constellations, celestial motions, and sky events. With the images taken at important cultural sites around the world, the connection between our many cultures and the night sky through history is emphasized, particularly in images that include ancient sites of astronomical importance.

Alan Gilmore and **Pam Kilmartin**, Mt John Observatory, University of Canterbury

Astrometric observations of Near-Earth Objects from Mt John Observatory

Karen Pollard, School of Physical and Chemical Sciences, University of Canterbury. Director Mt John Observatory, Lake Tekapo

Astrophysics Research at the University of Canterbury Mt John Observatory

Lei Ping, China Biodiversity Conservation and Green Development Fund (CBCGDF), Shenzen, Guangdong Province, China

The Exploration of the Way of Sky Protection

For thousands of years, human beings have been looking up at the stars. However, in the past hundred years, light pollution has spread due to overuse of illumination and urban expansion. Two-thirds of the world's cities have lost sight of the galaxy and the major constellations. The night environment of human and the biosphere has been destroyed and eroded, astronomical observations have been disturbed, and the common astronomical resources and heritage of human are being lost. The dark sky is the common, universal natural, cultural resources, and heritage of people, and it is an inseparable part of our ecological environment. It is of great significance to pay attention to coping with the increasingly serious light pollution, to maintain the night environment on which all kinds of animals and plants depend, and to enable human beings to observe and enjoy the charm of the stars from generation to generation. Therefore, in order to protect the dark sky in China, the China Biodiversity Conservation and Green Development Foundation (CBCGDF) focus on the protection of dark sky, promoting legislation on light pollution and starlight travel, as well as public promotion and awareness education. At present, based on the investigation, the CBCGDF has set up 5 pilot protected areas. Furthermore, we will put insects together into the work of dark sky protection.

Liu Hao, China Biodiversity Conservation and Green Development Fund (CBCGDF), Shangrao City, Jiangxi Province, China

Protecting the Dark Sky, Building a Beautiful China

(I) China's Efforts in the Prevention and Control of Light Pollution

1). Chinese Government is taking action to prevent and control light pollution;
2). Chinese civil society is taking action to prevent and control light pollution;
3). Chinese sagacious elites are taking action to prevent and control light pollution.

(II) The Establishment of "China Dark and Starry Sky Conservation Area • Geyuan

1). Brief introduction to Geyuan Town, Hengfeng County. Geyuan Town, is located in Hengfeng County at Jiangxi Province, China, and has a great original ecological environment. Geyuan Town is covered with terraces, ancient roads, ancient trees, ancient bridges, pebble roadways and other natural landscapes. It has lush natural forest oxygen bar, fresh air, better night sky quality, less light pollution, and is an excellent star-watching place.
2). The discovery of Geyuan's "Dark Sky";
3). The establishment of "China Dark and Starry Sky Conservation Area • Geyuan".
In 2016, Geyuan Town's great ecology was recognized by the local government and China Biodiversity Conservation and Green Development Foundation (CBCGDF), and finally in 2019, "China Dark and Starry Sky Conservation Area • Geyuan" was officially established.

(III) Future Construction and Development of "China Dark and Starry Sky Conservation Area • Geyuan"

1). Achieve consensus and promote project construction by professional team;
2). Rational planning and scientific expansion of the functions of conservation area;
3). Support and participation from all walks of life in the future.

Session 8: Artificial light at night and its impact on the environment

Karen Arthur, Ministry of the Environment and Energy, Australian Commonwealth Department of the Environment and Energy, Canberra, ACT, Australia (✶)

Development of *National Light Pollution Guidelines for Wildlife* in Australia

Artificial light at night can disrupt critical behaviours in nocturnal wildlife. Where this occurs in threatened species, artificial light has the potential to stall the recovery of a population. Where it occurs in migratory species, the impact of light may compromise an animal's ability to undertake long distance migrations integral to their life cycle.

The Australian Government, in association with Pendoley Environmental, is developing *National Light Pollution Guidelines for Wildlife, including Marine Turtles, Seabirds and Migratory Shorebirds*. The Guidelines provide a framework to address the potential impacts of artificial light to wildlife. They provide best practice lighting design principles, and a risk assessment and continuous improvement approach to the management of artificial light near susceptible wildlife. The guidelines also provide species specific considerations, mitigation technologies and techniques for marine turtles, seabirds and migratory shorebirds.

Karen Trevino, US National Park Service, Denver, CO, USA (✶)

Starcrossed: Preserving Night Skies in US National Parks

Some of the best places to stargaze in the United States are in national parks. Stellar views of the cosmos are often a quintessential national park experience and astronomy based recreation is one of the fastest growing visitor programs in U.S. national parks. More than half of IDA's 47 Dark Sky Parks in the U.S. are units of our National Park system. Further, many national parks that have not been certified as an IDA's Dark Sky park, provide visitors with outstanding night sky programs. The USNPS Natural Sounds and Night Skies Division provides technical support to parks to preserve natural lightscapes and address the effects that outdoor lighting can have on not just dark night skies, but also on wildlife, health and safety, cultural resources and wilderness character. The NPS Night Skies program is relatively new and Karen Trevino, the Natural Sounds and Night Skies division chief and will share her experiences, successes and challenges in turning a small, little known program into a national success. She will also share some of the tools and technologies used by NPS for measuring sky glow, summarize salient research regarding the effects of outdoor lighting on wildlife and park visitors and discuss how outdoor lighting can effect national park resources and values.

Jeff Dalley, Department of Conservation, Christchurch, New Zealand

Sounds and lights in the environment

Gareth Hughes, Member of Parliament and Green Party Tourism Spokesperson

Treasuring our dark skies for our people, our environment and for the world to see.

Green Party MP and tourism spokesperson Gareth Hughes explores the potential for New Zealand's dark skies to become a beacon for travellers and stargazers worldwide. He'll look at the opportunities for local and central governments to work in partnership, to treasure our astral landscape and embrace the benefits of dark sky policies on people and the environment.

Session 9: The End of Night; Dark sky protection in Indonesia

Paul Bogard, James Madison University, Harrisonburg, Virginia, USA (✶)

Is it the End of Night?

A starry night is one of nature's most magical wonders. Yet in our artificially lit world, most of us no longer experience true darkness. In this talk based on his book THE END OF NIGHT, Paul Bogard seeks to restore our awareness of the spectacularly primal, wildly dark night sky and how it has influenced the human experience across everything from science to art.

Using a blend of personal narrative, natural history, science, and astronomy, Bogard shares the importance of darkness--what we've lost, what we still have, and what we might regain--and the simple ways we can reduce the brightness of our nights tonight.

Premana Premadi, Bosscha Observatory, Institute of Technology, Bandung, Indonesia

Developing Dark Sky Protection Strategy in Indonesia (co-authors: R. Breton, D.Y. Yuna and O. Katz)

Whilst astrophysical research requires deeper and finer observations that demand clear sky, the increasing air and light pollutions have become a more serious impediment for further advancement. Most of the pollution sources are identified as effects of urbanization and industrial development. Indonesia is a developing nation where often environmental problem becomes an issue when significant damage has been done. The current government has issued regulations to protect the environment that we refer in deriving more specific ones to curb light pollution.

We develop a strategy to protect dark sky over Indonesia that will benefit not only astronomy, but more importantly the natural ecosystem for which human is the guardian as well as the beneficiary, in line with the Sustainable Development Goals. The aim of this work is to have an integrated strategy that will materialized as regulations on artificial light usage that will be whole-heartedly respected and followed through good understanding. This requires awareness raising and engagement effort with stakeholders: centre government, local government, industries and corporates, and most importantly citizen at large. Thus far education has been the best promotion mode, with partnership with schools and universities as a sustainable strategy.

In addition to promoting better life quality, we elaborate various possible economic incentives that should be of interest. Among others, we incorporate ideas of astrotourism as an increasingly attractive vacation mode as well as an eco-friendly economic drive.

Dwi Yoshafetri Yuna, Bosscha Observatory, Institute of Technology, Bandung, Indonesia

Why East Nusa Tenggara should be an amazing destination for astro-tourism

(co-author: P.W. Premadi)

Using scientific method, we determine potential locations for astrotourism destination in Indonesia. It is based on geospatial analyses which includes sky brightness, cloud coverage, air, and terrain condition. To align with the national tourism development, we apply this method to evaluate the potential of astro-tourism at existing tourist destinations all over Indonesia. We found that East Nusa Tenggara Province astronomically and climatologically meet all the requirements and classified as first class potential. East Nusa Tenggara is blessed with proper climate for astronomy observation and enriched with beautiful landscapes and traditional culture including folklore of celestial objects. It is no wonder that

East Nusa Tenggara has many of tourist destinations, with several of them being world class destination, e.g. Komodo Island. With all these potential, East Nusantara should be a capital of astrotourism in Indonesia.

The modern astronomical observatory in Timor Island, East Nusa Tenggara Province, which will be inaugurated in 2021, should increase a wider interest in astro-tourism as the facility gains international recognition.

In this paper we show the result of strength, weakness, opportunity and challenge study on developing astro-tourism in East Nusa Tenggara as a new concept of tourism in Indonesia.

Hendra Agus Prastyo, Bosscha Observatory, Institute of Technology, Bandung, Indonesia

Spatiotemporal Analysis of Light Pollution Distribution Patterns around observatories in Indonesia (co-authors: D. Herdiwijaya and P.W. Premadi)

Today many observatories around the world encounter challenges due to the increasing light pollution, especially those which are relatively close to urban areas. One of them is the Bosscha Observatory in Indonesia in the western part of Java. We need to raise public awareness of the need for dark sky protection. In order to do that we need to show how light pollution and its impact increased through the years. We do a Spatio-temporal analysis of the night sky brightness condition using data from VIIRS-DNB satellite imagery centered at the Bosscha Observatory around a radius of 20 km within years 2013-2018. Using this data we build an unsupervised method of classification to separate degrees of light pollution into five classes, which suggests the digital mean interval value of each class from the Bosscha Observatory. We then adopted these classifications of light pollution level as a supervised classification for other areas in Timor and Sumatra, where two mid-size astronomical observatories are under construction. The results showed that the area with very low light pollution decreased, while the areas with low, medium, high, and very high light pollution levels increased with the varying annual rate. The distribution pattern of each class is also affected by the geographical form. Medium, high, and very high classes have a tendency to agglomerate in urban areas and their distribution patterns follow the road network, while the very low light pollution level class has a tendency to agglomerate in hilly and mountainous areas.

Keywords: Light Pollution, VIIRS-DNB Satellite Imagery, Observatories in Indonesia

Session 10: New Zealand Aspiring Dark Sky Places – Towards a Dark Sky Nation

Kyra Xavia, Dunedin

Protecting Ecology and Saving Our Stars via a Constellation of Small Amber-lit Coastal Communities

On behalf of the Dunedin Dark Skies Group and the Lightwise Guild, Kyra Xavia discusses the journey involved in protecting the nights skies of Dunedin. She touches on the challenges faced by councils in New Zealand regarding LED lighting technology, explains the drawbacks of most existing LED light sources and why many retrofits fail to deliver safe, appropriate, effective illumination. Most importantly she suggests solutions, and in summary, explains how the search and ongoing campaign for biologically/ecologically responsible illumination has resulted in approval for shielded, low-glare, amber 2200 K LED lighting for certain areas of Dunedin.

Damien McNamara, North Otago Astronomical Society, Oamaru, NZ

Using darkness to enlighten

Ralph Bradley, Wai-iti, Nelson, NZ

In the dark at the top- Happenings in the Top of the South

Ralph Bradley will briefly explain who the Top of the South Dark Sky committee are, and who our parent bodies are. We are part of the Astronomy section of the Nelson Science Society. Secondly, an explanation of what got us thinking about Dark Skies through a personal dilemma of where to personally build an observatory and then how the committee started. Thirdly this is to be followed by a history of what we have done. To date, we have taken light readings in the area, formed a committee and after 4 years have a MOU with the TDC to use public land as a dark sky park. We are now preparing our application to IDA. Finally an explanation of what we are hoping for in the future. This could be a dark sky New Zealand, by creating as many dark sky areas as possible in our area, hopefully using large DOC estates.

Jill Wolff, Naseby Vision, Naseby, Central Otago, NZ

The long and winding trail

Naseby sits in the Maniototo, in Central Otago, and is showcased by many natural beauties, one of those being our night sky. IDA accreditation as a Community was a logical step in creating a community culture of guardianship to protect our skies, and to create opportunities. That "step" has developed into a staircase, wrought with challenges, pitfalls, and huge learning curves. Naseby Vision (the "go get it" behind this initiative) is an Incorporated Society with 370 members, with a small but passionate committee and strong support from the Central Otago District Council, and is still focused on achieving our final "tick" from IDA. This is a light-hearted (non-technical) overview of our progress, finishing with what Naseby currently offers.

Alistair Brickell, Stargazers B&B and Astronomy Tours, Whitianga, Coromandel, NZ

Stargazing on the Coromandel peninsula

Ken Ross, Far North District Council, Kaikohe, NZ

He kanohi ki te kanohi /Face to face

The North Hokianga Dark Sky Reserve proposal explores the challenges and opportunities inherent in introducing the Dark Sky conservation concept to Te Ao Maori (the Maori world).

Kim Wesney, Waiheke Island, Auckland

Good Night Waiheke or Good Bye to the Night Waiheke?

Imagine… as the next suburb over from the brightest center in NZ, you step off the boat and it's subdued, dark, beautiful, the stars are just there…. Is it a Good Night Waiheke or …Goodnight (Goodbye to the night on Waiheke)….that is our challenge.

What are the challenges and benefits of encouraging an island dark sky community close to Auckland?

Clare Quirke, Selwyn District Council, Rolleston, NZ

Letting stars reflect in Te Waihora and the moon light up Te Tiritiri-o-te-moana: Selwyn District plans to protect the Dark Sky

Selwyn is the third largest territorial authority in the South Island covering an area of 6420 km's. It has been New Zealand's fastest growing district over the past 10 years with an average of 5% growth per annum. Projected growth for the district is expected to reach 79,200 by 2028, and 104,000 by 2043. Selwyn has a young population profile, with an average age of 37 years. Almost a quarter of our residents are aged under 15 years.

Our aspiration is that every person in our district—either visiting or living here—has the opportunity to experience the outstanding quality of our dark sky. And that gazing up at the stars and connecting with the cosmos is part of every child's experience and adult's memory.

Selwyn District has a unique and special landscape that ranges from the mountains to the sea. The darkness of the vast and remote hinterland, the lakes, and the dark core around the West Melton observatory provide an opportunity for a genuine and important commitment to protection of the dark sky.

Ricky Clarkson, Wainuiomata/Orongorongo Park Ranger, Greater Wellington Regional Council

The Wainuiomata-Orongorongo Dark-sky Project.

I will present a general outline of the Wainuiomata-Orongorongo Dark-sky Park Project and the goals of where we are going. At the moment we are fairly convinced we can meet the requirements for IDA accreditation. By October we should have made some good partnerships and have our monitoring network set up.

Session 11: Towards a Dark Sky Nation

Steve Butler, RASNZ Dark Skies Group, Invercargill and **Nalayini Davies**, ASTRONZ and Auckland Astronomical Society

Towards a Dark Sky Nation – the vision, the challenges and opportunities

The concept of a Dark Sky Nation is quite new and is under consideration by the International Dark-Sky Association (IDA). Nalayini and Steve will describe the concept as it stands, explore the benefits of this new designation and consider how New Zealand Aotearoa might perform at the moment. This presentation will also seek to identify the work required and the interest there is to achieve this designation.

Starlight Conference Posters

Andrea Sosa Centro Universitario Regional del Este (CURE), Universidad de la República, Rocha, Uruguay

Towards the creation of the first dark sky reserve in Uruguay

The province of Rocha, in Uruguay, has 200,000 hectares of lagoons, morass, streams and rivers, declared as “Reserva de Biósfera” by Unesco in 1976. Uruguay has 16 areas integrated into the National Protected Areas System (SNAP), of which 5 are located in Rocha. Protected areas contribute to the preservation of the country's natural and cultural heritage, while promoting sustainable development that creates opportunities for local communities. On April 23, 2019, an agreement was signed between the Institute of Colonization (INC) and the Eastern Regional University Center (CURE) of the Universidad de la República, for the management of a site in the “India Muerta” region, characterized by its rich biodiversity, beautiful natural landscapes bordered by mountains, and located in one of the darkest sky regions of the country. Preliminary measurements of the brightness of the sky with the SQM have yielded values between 21.7 and 21.9 on the periphery of the region.

This site contains numerous "Indian Cerritos"; buildings made by the original inhabitants thousands of years ago, which are seen as elevations covered by native forests. It is the first time that a group of Indian cerritos has passed to state lands, and also to be managed by scientists of the University. The archaeologists Gianotti and del Puerto have determined that some of the Indian cerritos of this region are among the oldest in all South America. Because of their great fertility and elevation, over them native forests are developed with plant and animal species, many of them are a priority for conservation. In addition, it seems that the original inhabitants of the cerritos used the Southern Cross constellation as a temporary and seasonal marker, so the site has potential for Archaeology and Ethnoastronomy. We conclude that the place has excellent conditions for the development of cultural and astronomical tourism.

Nalayini Davies, Auckland Astronomical Society, Auckland

Comparative Study of Variations in Night Sky Brightness in Auckland

This pioneering pilot study of comparative night sky brightness (NSB) at four distinct and diverse Auckland locations has (i) established scientifically robust baseline NSBs for 4 of Auckland’s 21 Local Board Areas, (ii) created a reliable and robust monitoring system and methodology for a longer-term follow-on project to study wider areas of Auckland and the ongoing NSB evolution as Auckland rolls out its LED transition (a rare opportunity), and (iii) has ascertained the extent to which Auckland NSB is influenced by a mix of natural and

artificial factors. The project methodology extended to adopt back-up sites, discovered the Eastern half of Waiheke noticeably darker as previously thought. Sharing the findings of the project with Auckland's planning and regulatory community and Local Board Management has acted as a catalyst in generating momentum, engaging and motivating the parties to develop a sustainable approach to reducing Auckland's light pollution. The longer-term project is expected to (i) assist the regulators and planners, (ii) produce scientifically useful results for IDA as the first scientifically monitored NSB evolution through a major city's LED transition, (iii) facilitate national and international collaboration, and (iv) engage the public.

Clive Ruggles University of Leicester, UK

Hawaiian stars and Polynesian navigation

The publication in 2015 of the second edition of *Nā Inoa Hōkū: Hawaiian and Pacific Star Names*, by Hawaiian scholars Rubellite Kawena Johnson and John Kaipo Mahelona together with the current author, has drawn attention to the fact that there was no single tradition but a complex and dynamic body of astronomical knowledge in the Hawaiian Isands, as elsewhere in Polynesia. Hawaiian-language archival sources, often fragmentary, combined with archaeological/archaeostronomical evidence, reveal much more than just the use of star observations for navigation and wayfinding, hugely important as this was: they could also, for example, be for calendrical purposes or religious/symbolic in nature. Certain Hawaiian star names also have the potential to shed important new light on beliefs and practices brought to the Islands by the earliest Polynesian settlers.

Although a number of Hawaiian names for particular stars are well known, the great majority of Hawaiian stars remain unidentified. In this talk I shall describe recent efforts to provide western identifications for more of these. This is more complex than it would seem as many of the historical accounts contain statements that, from a modern western viewpoint, appear to be contradictory or nonsensical. Added to this, particular star names are not always consistently applied to the same stars: even within a single custom a particular name may only be applied to a particular star at certain times or in a certain set of circumstances.

Such work complements the achievements of the Polynesian Voyaging Society in recreating navigational traditions based on traditional forms of star knowledge. It helps provide the most reliable possible historical basis for the living tradition.

Damien McNamara, Oamaru, New Zealand

The dark side of light

Karen Pollard School of Physical and Chemical Sciences, University of Canterbury

Astronomy, Astrophysics and Cosmology Teaching and Research at the University of Canterbury

Phil Langill, Rothney Astrophysical Observatory, University of Calgary, Alberta, Canada

Measuring and Monitoring Darkness at 10,000 feet (with Jade Jewel, GM/Springbank Air Training College)

When a lighting engineer tells you, 'this won't increase the brightness significantly', do you wonder, 'how do they know that?'. Or when you learn that City Planners 'won't go there because it's against code', do you wonder, 'who made up that code?' When faced with these depressing words I automatically think, 'I really ought to do that measurement myself'. The City of Calgary and the Province of Alberta are embarking on major projects which could seriously increase the brightness of the sky at night over the RAO, and my skeptical curiosity has led to a rather ambitious project that involves placing sensitive light measuring instruments (SQMs) high above these soon to be developed areas, using a Cessna 172 flying at 10,000 feet. The goal is to measure the baseline of brightness before the street and highway lights are turned on, and then repeat the measurements in future after the projects are complete - thus quantifying the brightness changes to determine if the engineers and planners got it right. This poster explains this experiment thus far.

Kirsty Phillips Dark Sky Project, Lake Tekapo.

Two posters on the work of the Dark Sky Project, Lake Tekapo

Günther Wuchterl, Vienna Natural History Museum and Kuffner-Observatory, Vienna, Austria

Nature at Night as a Habitat

Light management and didactic methods are explained and first results are shown concerning monitoring and directional assessment of sources of artificial sky brightening in the two new and first World Natural Heritage Sites in Austria - the Kalkalpen National Park and the Dürrenstein Wilderness (inscribed 2017). Results include an analysis of the development of nighttime total radiation in the Eastern Alps from 2010 to the current solar minimum and high-definition, >2pi imaging photometry of the light-distribution of the nightscape - to quantitatively analyse the flow of light in the star- landscape systems of the sites.

While serving the protection of the site, the all-sky-and-landscape images illustrate the beauty of the night for use in "full-dome" systems and reconnect the audiences in light-polluted areas to the "natural night" by combining the imaging with audios and exhibitions

of the native night-active species of the sites.

The methods are developed for the management plans of the two new World Heritage sites, as well as the Donau-Auen (Danube wetlands) national park and assist the ongoing efforts for the "Hallstatt-Großmugl mines and tumuli" project to establish a cultural World Heritage site with a significant contribution of starlight to the outstanding universal value and its protection.

Alison Loveridge, Dept. of Sociology and Anthropology, University of Canterbury, Christchurch, NZ

Dark sky networks: an international comparison

Organisations such as the IDA insert a transnational network into the protected mountain landscapes of the south-west of France that Samuel Challéat and the Night-time Environmental Resources & Territories (RENOIR) team have studied since 2013. The designation of night landscapes by the IDA is understood by RENOIR as a politicised process that encourages the ecologisation of the economy. Challéat and his colleagues analyse the environments of the night using three categories to identify effective conservation actions and networks. They show how *anthropocentric utilitarian* initiatives such as astro-tourism, work alongside *integrated social-ecological* initiatives introducing dark sky friendly lighting which normalises attending to the needs of living creatures to experience natural diurnal rhythms. Popular support for lighting control grows from these initiatives to a greater extent than from the *ecocentric conservation* initiative for the protection of bat habitat by strict lighting control within a national park. These insights are worth considering in other institutional constellations than the French alpine areas in which the RENOIR interdisciplinary team developed their analytical framework. An IDA reserve, park, or sanctuary may overlay private land or conservation estate. Funding for conservation work within it may come from private sources or public/private partnerships as well as central or local government. In Aotearoa New Zealand (ANZ), the Treaty of Waitangi claim settlements have brought unique designations into being. This presentation will look briefly at the institutional constellations in two IDA reserves in ANZ and Wales using the RENOIR framework.

Duncan Steel, Xerra Earth Observation Institute, Alexandra, NZ

The View from the Sky: How NZ Appears at Night to an Astronaut

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ASTRONZ, Auckland Astronomical Society, Auckland, NZ

The International Dark Sky Association, Tucson, AZ, USA

Fundación Starlight, Tenerife, Spain

Christchurch International Airport Ltd, Christchurch

University of Canterbury, School of Physical and Chemical Sciences (courtesy of Prof Rudi Marquez)

Alpine Recreation, Lake Tekapo (courtesy of Ann Braun-Elwert)

Fairlie Bakehouse, Fairlie (courtesy of Franz Lieber)

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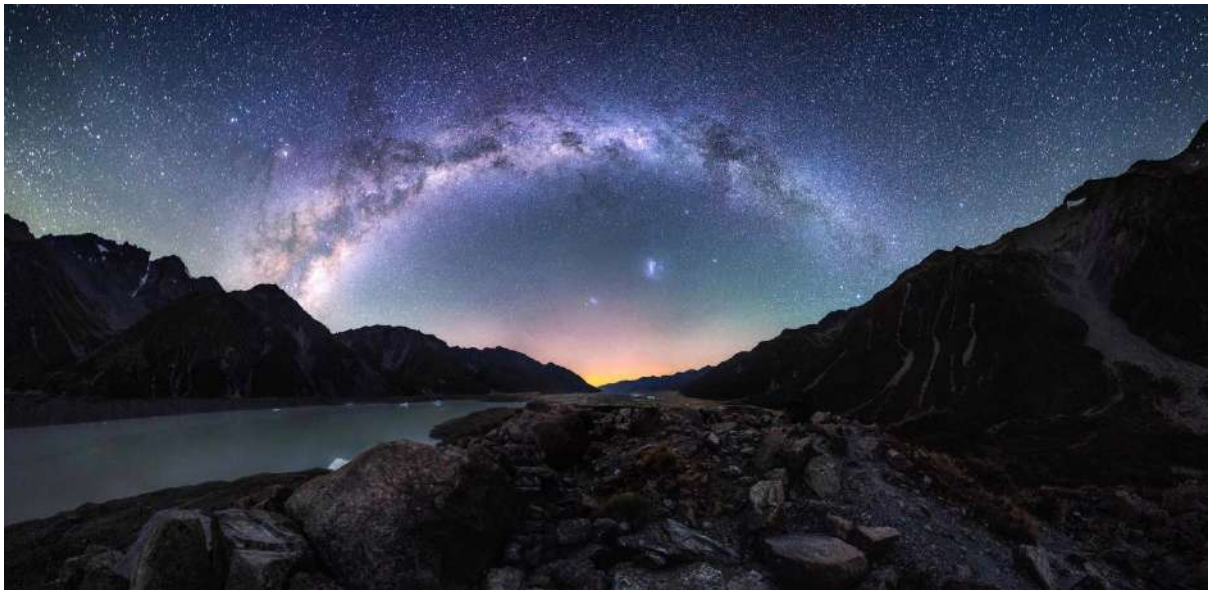

Valley of the stars, Tasman Lake, Aoraki/Mt Cook National Park

Photo: Mark Gee

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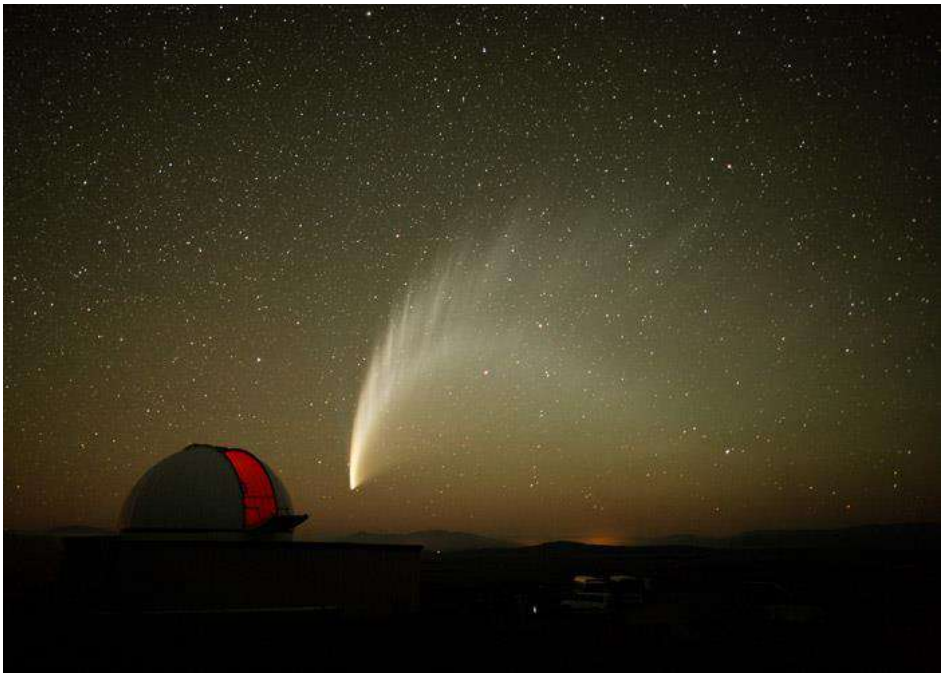
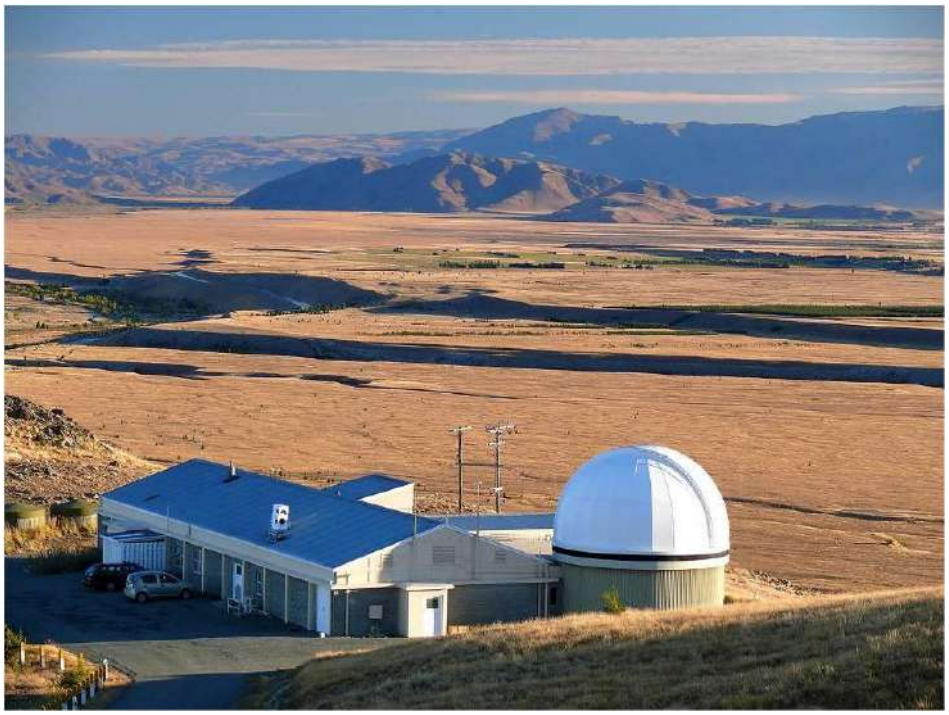


Comet McNaught seen at Mt John Observatory, January 2007

Photo: Fraser Gunn



1-m McLellan telescope building at Mt John Observatory

Photo: Fraser Gunn