galaxies etc. Developments in array technology, image processing etc has enabled more sophisticated observations especially with higher angular resolution.

However, the situation may NOT allow the human being to enjoy this improvement fully. Protected bands are very narrow here, because this is the most crowded frequency band and allocation is given in terms of very small widths.

High resolution observations will become possible by use of arrays of space baselines. A different set of protection criteria will become necessary.

300–30000 MHz (dm to cm waves)

This is the band where most of the important discoveries were done and developments in new technology are in progress, but on the other hand, the most intensively used band by communications and other purposes. New demands such as satellite systems for personal pocket phones etc are rapidly growing but there is no resources of unused bands.

Situation will become more serious as more and more new demands will require space to earth transmission with relatively high power and to cover essentially whole surface to the earth. If some substantial measure NOT taken, human eyes in this important spectrum will be black out.

Above 30 GHz (mm and sub-mm waves)

Molecules in the interstellar clouds display a very large number of spectral lines mainly through rotational transition. It provides an unique possibility of direct observations of cool gas phase in Universe. Interference situation is not YET serious.

The band is not used very actively because of the cost and technical demands will be pointed to this area very soon.

Frequency as the treasure of Nature

Originally, communications lived in a small area, perhaps below 50MHz. After the 2nd World War, the "big march" to the higher frequencies started and conquered the whole microwave region, which was, although sparsely, already inhabited by radio astronomy. Conquers allowed the original inhabitant to survive within narrow protected areas.

Frequency is like land. It is finite and easy to use up. It belongs to Nature. It is NOT owned by anyone.

Developments in the technology is at present encourage demands to USE the new frequency bands rather than protecting it, or in other words, Nature is protected only be the technical difficulties to use the band rather than the human wisdom.

Conclusion

We are about to lose the radio sky, which has continuously provided fascinations to the human being. Just like in other frontiers of the conservation of Nature, a use of the human wisdom to protect Nature rather than destroying is only the solution out or it.

3. LIGHT POLLUTION: ITS DAMAGE TO EDUCATION AND CULTURE

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One could argue that light pollution has no impact on education or culture, because so few people care about real science. Perhaps people prefer bright lights, and "space art". The word *education*, however, comes from the Latin word *to lead*, and *culture* obviously refers to cultivation. It is our responsibility to educate the public in astronomy, and in the issues related to light pollution and related topics, and to cultive their appreciation of the night sky, and the universe.

Astronomy is important to education and culture because of its deep historical roots, its practical and philosophical applications, its aesthetic and emotional appeal (the beauty of the universe, and the sense of shared exploration and discovery), and its message about our place in time and space, and our cosmic roots and environment. In the classroom, it demonstrates the observational approach to the scientific method, and is a wonderful tool for teaching concepts of light, and gravity. It attracts young people to science and technology, and promotes public interest in science. Like all science, however, it is best taught through inquiry—simple, "hands-on" (or "eyes-on") activities. This is difficult in light-polluted skies.

Ironically, light pollution provides interesting opportunities for student projects, because it has scientific, technological, and societal aspects. Several groups have developed such projects, including co-operative, Internet-based projects in which students measure light pollution with simple devices,

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and then send their measurements to a central database. Students can also study light sources in their neighbourhood, using simple transmission diffraction gratings—a good cloudy-night activity!

Light pollution also hinders the recruitment, training, and work of amateur (volunteer) astronomers. Amateurs make important contributions to astronomy research and education. Amateurs in many parts of the world—including Japan—have carried out important studies of light pollution, thanks to their skill and motivation. They are our allies—"grass-roots" voices for the preservation of the astronomical environment.

The issue of space debris is somewhat more difficult, since we have no control in the matter; most people, however, can relate to the problem, because of widespread media reporting of space activities. The issue of the pollution of the electromagnetic spectrum is even more difficult, because people have no direct experience with it, and they somehow feel that scientists can overcome any technological problem of this kind. Public education is an essential part of any solution.

What can we do about light pollution? We cannot just replace the real sky by the planetarium sky, or the computer screen—useful as these may be. We cannot expect people to travel to dark sites, even though the rich and motivated can do so. We cannot do all astronomy from space, even though this is a popular misconception. We must promote astronomy education and culture, and encourage our colleagues and students to do the same. We must educate ourselves about the preservation of the astronomical environment, and "spread the word". We must work with partners: teachers, amateur astronomers, lighting engineers, and the media, to achieve these goals. We must support organizations such as IAU Commission 50, and the International Dark-Sky Association. We must promote an appreciation of the night sky by making skygazing a part of our courses, and other activities. Few people who have seen a dark sky are unmoved.

4. NATURAL OPTICAL SKY BACKGROUND

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4.1. INTRODUCTION

Knowledge of the natural dark night sky brightness is required if one wants to set meaningful limits to the disturbance by artificial illumination. Knowledge of the behaviour of the natural dark night sky brightness is also required if one wants to monitor the sky for existing or changing light pollution. Therefore, before coming to quantitative results of night sky brightness measurements, we give an overview on the different components of night sky brightness and their different behaviour. From this, recommendations will result for the planning of future sky brightness monitoring programmes, as they are requested in the first of the proposed IAU resolutions to result from this joint discussion.

4.2. BRIGHTNESS OF THE COMPONENTS OF THE NIGHT SKY

The light of the night sky comes from several "layers" at vastly different distances. Neglecting the small contribution from extragalactic background light and the diffuse galactic light, which approximately can be taken as a 20% addition to the light of the stars, the main contributors to the night sky brightness are—the integrated starlight due to our own galaxy (15–200 S_{10} [1 S_{10} unit = one 10^{th} magnitude star per square degree = $2.17 \cdot 10^{-8}$ W/m^2 sr μm at B.]), —the zodiacal light, due to scattering of solar radiation on interplanetary dust (30–100 S_{10}), airglow emission from the high atmospheric layers (50–180 S_{10}), and scattering of these components in the troposphere. The light pollution, of course, results from troposheric backscattering. Tropospheric scattering contains two components: Rayleigh scattering, with almost isotropic distribution of scattered brightness, and Mie scattering by aerosols, preferentially scattering into the forward direction ± 30 °. These two components are present in the artificial sky illumination as well, i.e. the observable sky brightening towards a city is not the whole story. There is an almost isotropic Rayleigh component as well!

4.3. TEMPORAL VARIATIONS

Most of the variations are due to Airglow, sometimes by a gradual decrease during the night, but fluctuations and continuous brightness increases occur as well. Differences from night to night