Flagstaff: Dark Skies Tonight!

By Wes Lockwood

While "Dark Skies Tonight!" is not actually a local tourism marketing slogan, it conceivably could be owing to Flagstaff's astronomically friendly outdoor lighting controls. Recently, the International Dark Sky Association, a Tucson based non-profit organization devoted to dark sky preservation and improved outdoor lighting, awarded Flagstaff its first ever citation as an "International Dark Sky City."

Urban sky glow, or "light pollution" as we astronomers call it, is a subtle form of environmental degradation that often goes unnoticed, especially by city dwellers, many of whom have never seen the Milky Way. The upward shining light that causes light pollution not only brightens the sky but also wastes energy. A satellite view of the Earth at night (http://www.darksky.org/images/sat.html) shows that the problem is worldwide. *Physics Today*, a magazine that many of us receive, featured this view of the Earth on the cover of its April 2002 issue to dramatize global patterns of energy consumption.

Flagstaff has been a center of astronomical activity for over a century and a leader in outdoor lighting control for 40 years. A 1958 ordinance – possibly the world's first – prohibited searchlights because of their detrimental effects on astronomical work. In 1989, a major update tightened requirements for the shielding of fixtures and mandated low pressure sodium (LPS) fixtures for most outdoor applications such as parking lots. The City of Flagstaff has also adopted LPS for most of its street lighting system. LPS is unique as it is relatively easy to filter out of astronomical measurements. It is also by far the most energy efficient light source available.

How did Flagstaff's small group of professional astronomers persuade local government, citizens, and business interests to adopt outdoor lighting regulations? The scientific prestige of Lowell Observatory and the U. S. Naval Observatory carried some weight, of course, but more importantly, it was the common-sense low key but persistent efforts of former Lowell directors John Hall and Arthur Hoag that put Flagstaff on a path to better lighting. They began to educate local officials and citizens about light pollution and then suggested sensible steps to minimize it. Recent efforts continue in the same spirit.

Chris Luginbuhl of the U. S. Naval Observatory and I have now been involved in outdoor lighting matters for over a decade. We convinced city and county officials that a more comprehensive lighting code was needed and helped the staff specify the technical wording of the 1989 code update and subsequent revisions. While the lighting code addresses astronomical concerns specifically in establishing overall illumination caps in "astronomical zones" centered on the Naval Observatory and on Lowell's Anderson Mesa site, benefits to the community at large are addressed specifically in the Intents and Purposes section: "...to encourage lighting practices that will minimize light pollution, glare, light trespass; conserve energy and resources while maintaining night time safety, utility, security and productivity; and curtail the degradation of the night time visual environment." The Flagstaff and Coconino County lighting codes have served as models for other Arizona communities, most recently Camp Verde, Sedona, and Cottonwood, where nighttime aesthetics and dark sky visibility have popular support.

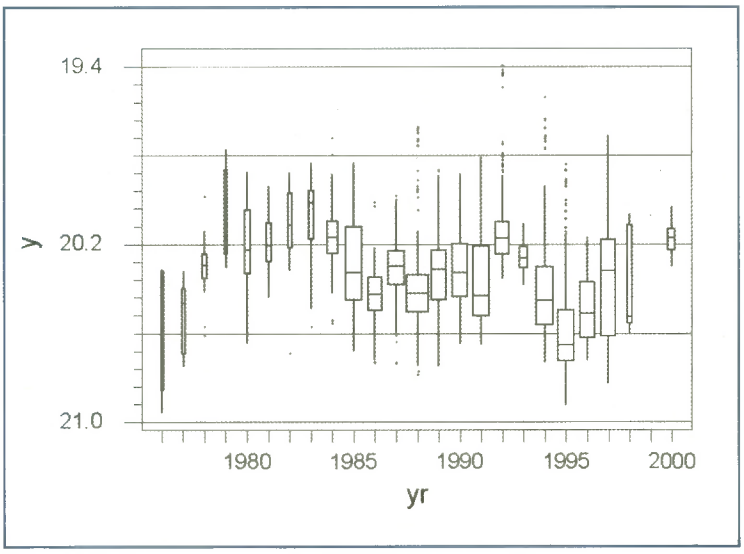

Figure 1.

How well do lighting codes work? Flagstaff has doubled in size over the past 25 years, but surprisingly the sky glow has not increased significantly above Mars Hill. We attribute this to the predominance of shielded fixtures in new installations and to the gradual replacement of mercury vapor streetlights with low and high pressure sodium (LPS on city streets, HPS on major arterials and highways). Both types of sodium lights provide good illumination for nighttime vision, but have little impact on measurements made through our colored filters.

These measurements have been made over a period of 2,600 nights since 1974 using the 21-inch telescope at Lowell Observatory, less than a mile from City Hall. Sky brightness measurements are a routine component of long-term programs of stellar and planetary photometry. We measure starlight through two colored filters called "y" (yellow) and "b" (blue), and then compensate for the contribution of sky glow by observing a patch of adjacent blank sky. The y filter is particularly suited to monitor the effects of a changing mix of light sources because it responds strongly to mercury vapor illumination but not to high and low pressure sodium. The b filter is sensitive to white light sources such as metal halide (common under gas station canopies) and fluorescent illumination.

The accompanying chart (Figure 1) shows the trend of annual sky brightness values measured in a small patch of sky directly above the 21-inch telescope. Tick marks on the vertical axis represent roughly 10% increments. The units are stellar magnitudes per square arc second of sky area. This particular chart is for the y filter, a rather narrow band of color that includes the spectral lines of mercury vapor but not the

yellow glow of LPS and HPS. This chart shows a rapid rise in the 1970s ended by the early 1980s. The rise may correspond to commercial development of South Milton Road close to the observatory. An actual decrease after 1985 indicates the replacement of obsolete mercury vapor lights (which our filter sees) with sodium lights (which our filter does not see). The results for blue light are similar. It is possible that another rise may have begun in the last few years, but the data do not yet indicate a clear trend.

Another way to monitor light pollution is by all-sky imaging. Recently Chad Moore and Dan Duriscoe of the National Park Service used a special electronic camera to image the sky from Mars Hill. They have been surveying sky brightness from western NPS sites and in May, they visited Walnut Canyon National Monument and Lowell Observatory. Over 100 separate frames are combined by a computer program to produce a single image like this one (Figure 2) obtained from the 21-inch telescope building on Mars Hill. The center of the picture is directly overhead, and the southeast horizon is at lower left, the same view you would have lying on your back looking straight up. I made parallel measurements with the 21-inch photometer to calibrate this image in stellar magnitudes. Contour levels on this picture represent ten percent increments of sky brightness. This picture shows us that the sky brightness above Mars Hill is not symmetrical. The darkest patch of sky is slightly northwest of the zenith. Sky glow is, not surprisingly, brightest in the direction of South Milton Road while the northwest horizon remains relatively dark.

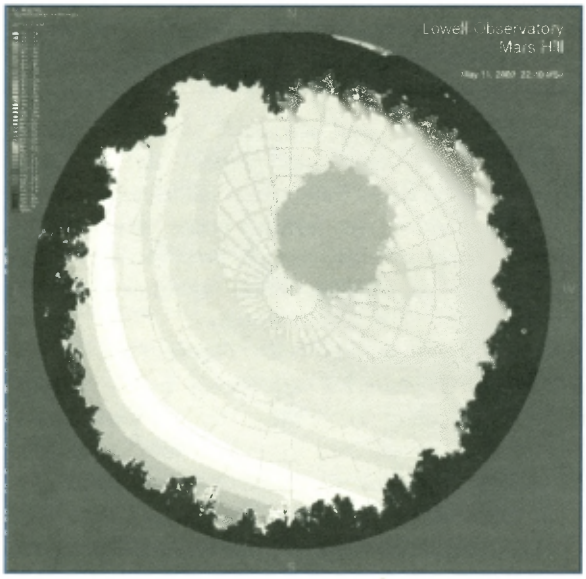

Figure 2.

Astronomical research in northern Arizona depends on our skies remaining relatively dark. Lighting control ordinances such as those presently in force, public support of dark skies, and measurements that will tell us how well we are doing give us some confidence that the prospects for continuing our work into the foreseeable future are good.★

Dark Skies over Africa

E.C. Slipher's Mars Expeditions to South Africa

By Kevin Schindler

When we think of expeditions of scientific discovery, we usually go back to such classic travels as Lewis and Clark's Corps of Discovery to the American frontier, Amundsen and Scott to the South Pole, or Roy Chapman Andrews and the American Museum of Natural History to Central Asia. When we think of expeditions to Africa, we might imagine big game hunting on a vast savannah. It's unlikely, though, that in either case we would think of astronomy being the goal of the expedition. Yet that's exactly what E.C. Slipher had in mind when he led expeditions to South Africa in 1939, 1954 and 1956.

By 1939, E.C. Slipher had established himself as one of the world's preeminent Mars observers. That year, Mars was going to be especially well situated for study, as it was nearing opposition. Even better, the opposition would happen when Mars was near perihelion, its closest approach to the Sun. These perihelic oppositions, which occur every 15-17 years, take place around July through September (such an opposition will take place in 2003, when Mars will reach its closest approach to Earth in thousands of years). Unfortunately, this means that for Northern Hemisphere observers, the planet is low in the sky, well below the celestial equator. This makes viewing less than ideal, because the atmospheric distortion increases as celestial objects approach the horizon.

Slipher wanted to continue his excellent record of Mars observations, and to best accomplish this he organized an expedition to the Southern


E.C. Slipher shows local students how to peek through a small eyepiece in order to experience the vast universe during the 1954 Mars opposition.