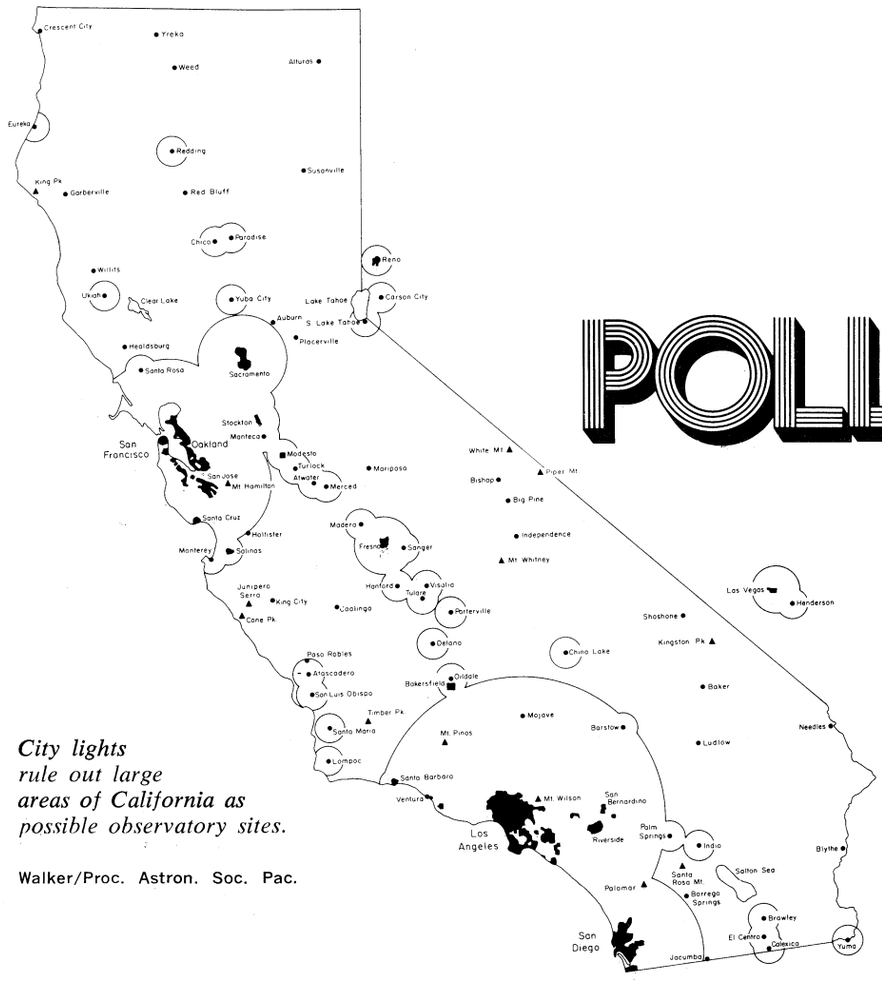
LIGHT POLLUTION

by Dietrick E. Thomsen



City lights rule out large areas of California as possible observatory sites.

Walker/Proc. Astron. Soc. Pac.

Optical astronomy is a science that is done in the dark. Astronomers would like to foregather on mountaintops with the inky black night that gives them the best view of the celestial bodies they wish to study.

But their researches are bedeviled by an age-old problem that is now becoming acute: city lights. Several of our largest observatories are finding that their mountains are no longer isolated. Urban sprawl laps around their bases, and in the telescopes the Great White Way competes with the Milky Way.

For centuries people have tried to turn night into day and have instinctively sought the light that astronomers wish would go away. Witness A. A. Hoag, W. E. Schoening and M. Coucke of Kitt Peak National Observatory writing in the PUBLICATIONS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC: "Humans instinctively shield themselves from the wonderful awe of the universe. The trend from campfire to lighted megalopolis has been a one-way demonstration of increased skill in this art."

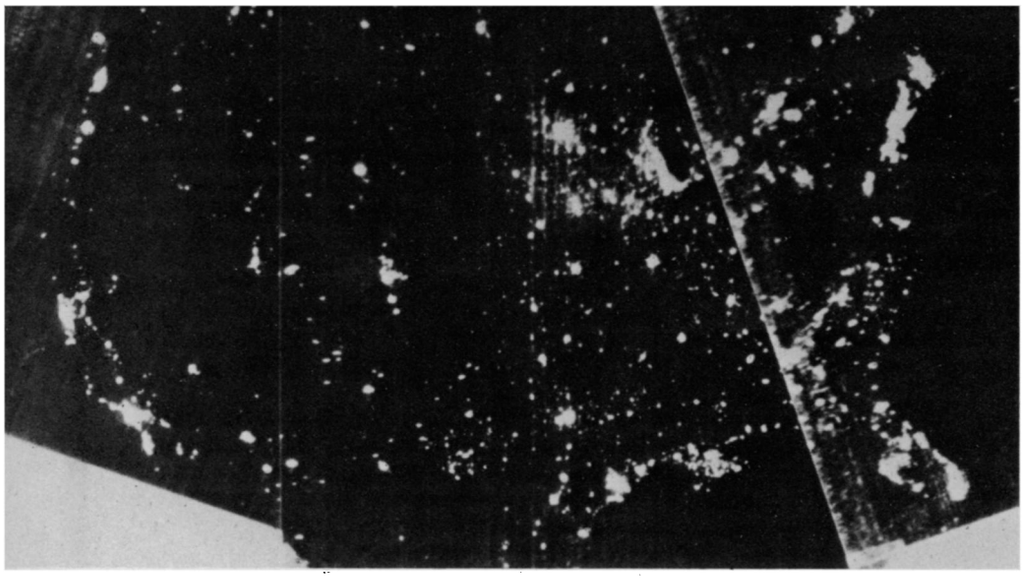
Lighted megalopolis may attract those down on the farm, but astronomers have a history of running from it. The problem is now more acute than ever because urban growth may leave them with no place to run. Back in the 1930's, when the 200-inch telescope was being planned, it was determined that the Mt. Wilson Observatory was not the place to put it. Mt. Wilson stands just above downtown Pasadena, and the competition from the lights of Los Angeles was deemed too strong for the faint objects (distant galaxies) the telescope was intended to study. The more isolated Palomar Mountain was chosen as the site. Today Palomar is beginning to feel the lights of Los Angeles and San Diego. Where to run next?

The experience of the University of California's Lick Observatory illustrates the tightness of the bind. When Mt. Hamilton was selected as the observatory's site in 1875, San Jose was a small town. (The city's population in 1900 is listed at 21,500.) Today San Jose is a metropolis of 445,779 (1970 census). The results of that growth have been variously detrimental to the observatory, according to a study made by Merle F. Walker of Lick.

The sky over Mt. Hamilton has brightened measurably over the last 20 years (the period of the greatest population influx to the Santa Clara Valley below Mt. Hamilton). Looking toward the zenith the faintest objects that can be detected with photographic plates or image tubes are now about one magnitude brighter than would be possible at a completely dark location. Looking 45 degrees above the horizon in the direction of San Jose, the faintest observable object is 1.5 magnitudes brighter than could be seen at a dark location. Putting all that in a slightly different way, for observations with photographic plates or image tubes the 120-inch telescope at Lick (one of the world's largest) is only about as effective as a telescope of 60- to 76-inch aperture located at a dark site. At Mt. Hamilton it now takes between 2.5 and 4 times as long to achieve a given photometric precision for an object of a given magnitude as it would at a completely dark site.

In addition, the spectral characteristics of the city light interfere with the spectra of celestial objects. Lines characteristic of mercury from the mercury vapor street lamps of San Jose appear on the spectra of celestial objects taken at Mt. Hamilton, and they become darker and darker as time goes on.

For these reasons Lick's managers have decided that any new large capital equipment that the observatory may build should not be set up on Mt. Hamilton. Looking for possible new



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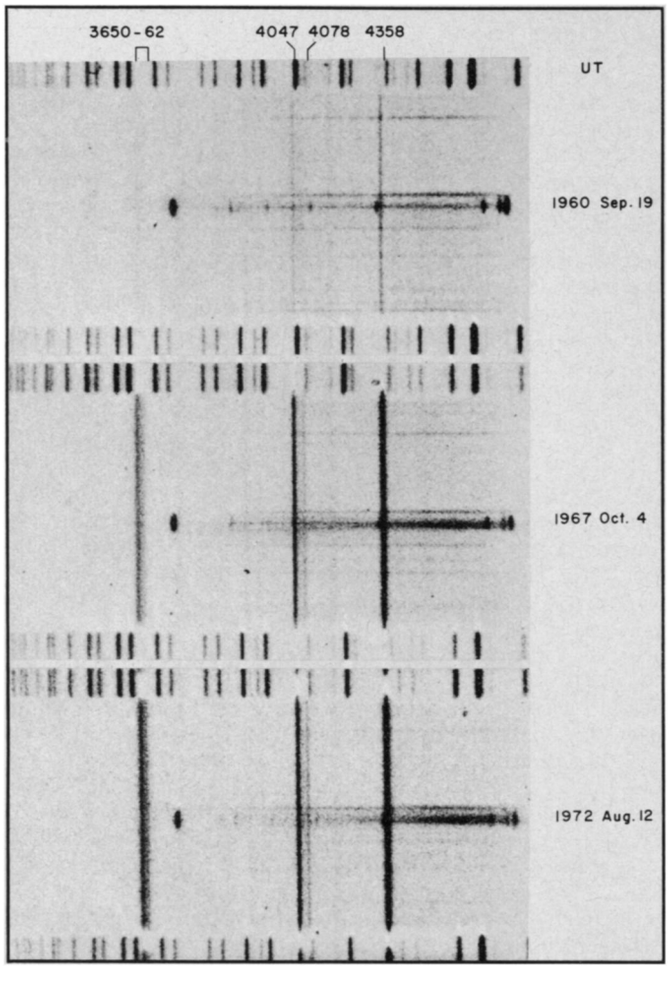
sites Walker prepared maps of California and Arizona on which he drew exclusionary circles around regions where urban light pollution was too strong for good observatory siting. The limits he used for sky illumination were those—still tolerable—found at Palomar: a sky brightness of 0.1 magnitude at the zenith and 0.2 magnitude at 45 degrees above the horizon in the direction of the nearest city. The resulting maps exclude vast segments of territory, and when they are combined with the other criteria for a good astronomical siting—lots of clear weather and low atmospheric turbulence—very few places remain. That is why Walker urges a program to identify good sites and preserve them from light pollution. Both the American Astronomical Society and the International Astronomical Union have appointed committees for this purpose.

The place the Lick people favor most as an escape hatch is Junipero Serra Peak in the Santa Lucia Mountains, somewhat south of Lick's present location. Junipero Serra lies between the Southern California and the San Francisco Bay Area conurbations, both of which are reaching toward it. At the moment the observatory has no money and no plans to build anything there, and thus is in a bad situation to try to affect what happens there. There are also potential problems because the location is in a national forest and there are conservationist groups that would like to see nothing at all built there, not even an observatory.

To preserve Junipero Serra would require control of lighting in the Salinas Valley. That might be achieved by legislation on lighting similar to that adopted in Tucson, where, as Hoag, Schoening and Coucke point out: ". . . astronomers have taken the perhaps quixotic view that something can be done about the lighting situation."

Tucson is surrounded by observatories (including Kitt Peak, the Smithsonian Astrophysical Observatory's southern station and the Steward Observatory of the University of Arizona), and it takes its "astronomy industry" seriously. The Tucson astronomers succeeded in getting the city to require the shielding of outdoor lighting so that it shines down but not up and to require that the spectral characteristics of outdoor lighting be such that emission of wavelengths shorter than 4,400 angstroms is curtailed. (Ultraviolet light is particularly bad for astronomers.) Lately the Arizona astronomers have persuaded the state legislature to pass enabling legislation so that counties and unchartered municipalities could enact similar ordinances. Now they are trying to get Pima County to pass such an ordinance. A county regulation would cover suburbs outside the city's corporate limits and the territory immediately adjacent to the observatory mountains themselves. "The ordinance won't reduce the light," says Hoag, and the light will continue to increase as a function of time. What the ordinance will do is reduce the slope of the increase. With this, good conditions can be preserved at Kitt Peak "not indefinitely" but for some time to come. The brightening at the zenith over Kitt Peak is now about 0.1 magnitude and more subtle features such as the gegenschein and the zodiacal band are easily seen at appropriate times, which means that the environment is quite acceptable for observations.

In places that are not as lucky and that have no controlling legislation, the situation will probably deteriorate even if the energy crisis shuts off a few lights and urban growth slows. Municipalities are moving from incandescent lamps to the brighter mercury-vapor lamps and the even brighter sodium-vapor ones. If something isn't done, American astronomers may wind up without a place to stand. □



Above: The United States lit up at night as seen by an Air Force satellite. Left: Spectral lines of mercury vapor (numbered) from the streetlights of San Jose appear in the spectrum of the nebula at FG Sge taken with the Lick Observatory's Crossley reflector. The intruding lines get darker as time goes on.

Walker/Publ. Astron. Soc. Pac.