How dark? How bright?

Any area might appear dark, when illuminated much less than the surroundings. Or it may appear bright, when it reflects the light source, like the Sun, into our eyes – even if it is rather black.

Various surfaces might be described as white. When put side by side, they may differ quite a lot. How much white they are? What is their “whiteness”? Scientifically, whiteness is called albedo, from Latin *albus*, white. It is a number ranging from 0 to (usually) 1, saying what proportion of incident light or another radiation is returned by surface away from it. Curiously, albedo is seldom expressed quantitatively, even on paints selling by claiming to to be “very white”. Do they return 99 % of radiation? Or just 80 % of it?

Such values are of importance for indoor lighting, to be measured using photometric quantities. But they may concern also the whole solar radiation, including invisible components; in such a case, energy flux quantities are to be employed. Solar, not just visible, albedo is the quantity from which the shortwave radiant heat flux absorbed by the Earth can be computed.

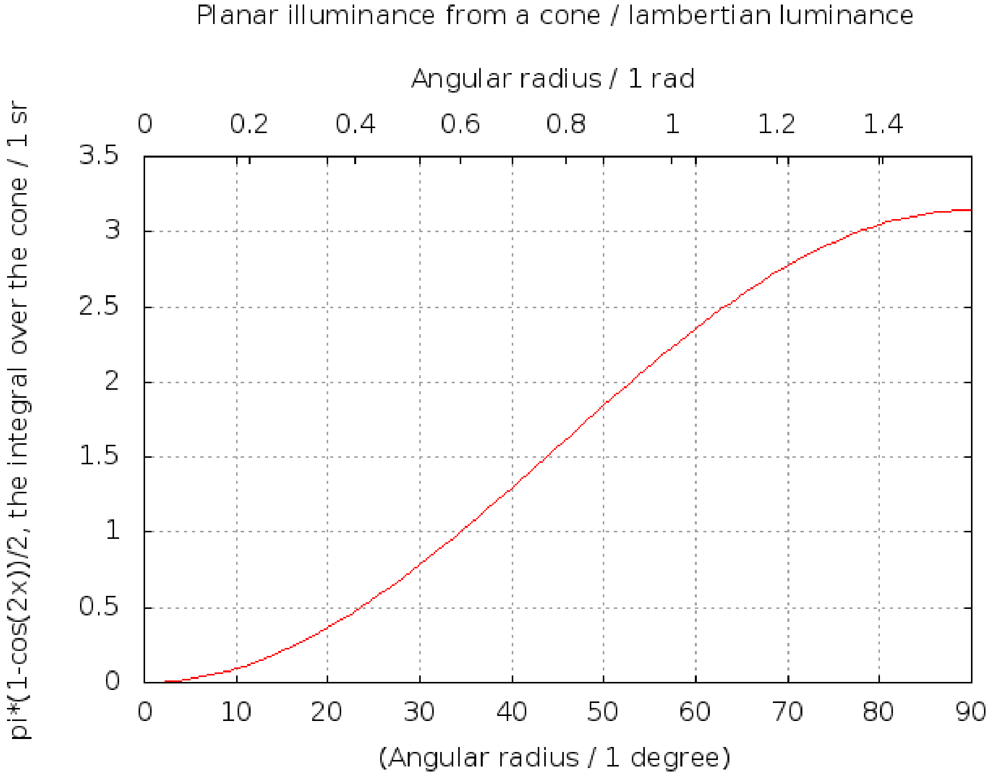
There are cheap instruments for measuring illuminance, luxmeters Visual albedo of a horizontal terrain is easy to get using them. Keep the sensor by a stretched arm (perhaps up to 3/4 m from yourself), some 0.2 m above the ground and point it to nadir (down to the ground). Stand in such a way that your shadow goes away from the sensor. Then take a reading taken when pointing the sensor to zenith. The ratio of these two values, that's the albedo. Let's call it visual albedo, as luxmeters try to mimick the spectral sensitivity of our daytime vision.

(The reading taken toward the ground represents the light sent upwards by it, whenever the sensor is “lambertian” – the signal recorded by it corresponds really to the illuminance of its front plane, that is, to the integral over 2 π sr space angle of flux density multiplied by cosine of the angle of incidence. Real luxmeters always try to approximate this property. You can check if it really holds. Point the sensor to a dominant light source, like the Sun, record the reading (should be tenth of a megalux for Sun high in the sky) and then another reading with a small shadow covering just the sensor. The difference is direct sunlight. Then attach the sensor to a long thin board, so that its entrance plane (or pupil) is parallel to the board. Point the board almost to the Sun, but so that its shadow cast on a perpendicular plane is ten times or five times shorter than its length. The plane shadow can be a ruler or a cardboard with the corresponding lengths marked. Again, two readings should be taken, one with a small shadow cast onto the sensor. A lambertian detector should measure direct sunlight illuminance of its entrance pupil as ten times or five times lower than previously.)

Similar semiconductor devices exist to be used as a proxy for solar irradiance, reporting their readings in W/m^2. Actually, they don't measure energy flux, but a photon flux, blue photons with high energy giving no more signal than infrared photons with low energy. Their sensitivity to spectral energy flux density is far from being flat; actually, it is similar to those of luxmeters, just broader, including most of the solar infrared component. Still, assuming a clear-day near-noon solar spectrum (direct sunshine plus blue sky), their readings for horizontal irradiance might be within several per cent of the true irradiance as measured by instruments recording real heat flux, called pyranometers. Good results might be obtained below overcast sky, too, as the resulting radiation is similarly colourless; the diminished infrared part, due to absorption by water, is correctly reported by the semiconductor irradiance meter. Just for strongly coloured light, like that coming from green vegetation, a proper coefficient is to be applied to arrive at a better estimate of irradiance,

For the start, such possible non-unit coefficients can be neglected and interesting data can be obtained by such meters on solar albedo, i.e. ratio of outcoming solar energy flux to the incoming one. How different may such solar albedo be from a visual albedo?

In reality, it may be not easy to measure the outgoing energy or light flux from a selected material, if the size of its surface is not large enough, occupying most of 2 π sr space angle toward which the sensor points. Of course, the space angle occupied by the inspected surface may be easily increased by moving the sensor closer to it. On the other side, the space angle occupied by the sensor's shade increases too. The shade makes less difference, however, if most of the illumination comes obliquely, what is often the case. But even if the sun would shine almost perpendicularly to the measured surface, the shadow cast by a sensor hold twice its diameter from the surface, occupies but 0.2 sr, just over 6 % of the integral of cosine of angle of incidence over the whole 2 π sr, which amounts to π sr. If the *observed surface radius would be five times its distance from sensor*, then just the remaining annulus of 0.2 rad width would be missing, what corresponds to a loss of some 5 % of signal. No problem, if the area surrounding the specimen is not much different from the specimen itself, that is, if its luminance is similar. If it differs a lot, an estimate can be made regarding its influence, similarly to an estimate of the influence of the sensor shadow.



A convenient way to hold a sensor is to attach it to a long thin narrow board. This way it is easy to ensure it is horizontal or paralled to the inspected surface. And you can hold easily far enough from yourself.

Our set was even more complex, so that simultaneous measurement could be done by two instruments. It could be two luxmetres, but in our case it was a luxmeter and semiconductor “sunmeter”. Either sensors can be upside or downside of its board. Such a twin configuration helps when the illuminance and irradiance varies a lot, like under quickly travelling clouds. Simultaneous readings are easy to capture by a photo.


VOLTCRAFT
PL-110SM
EXTECH
EasyView 30
85.2
RANGE
PEAK
lux
fc