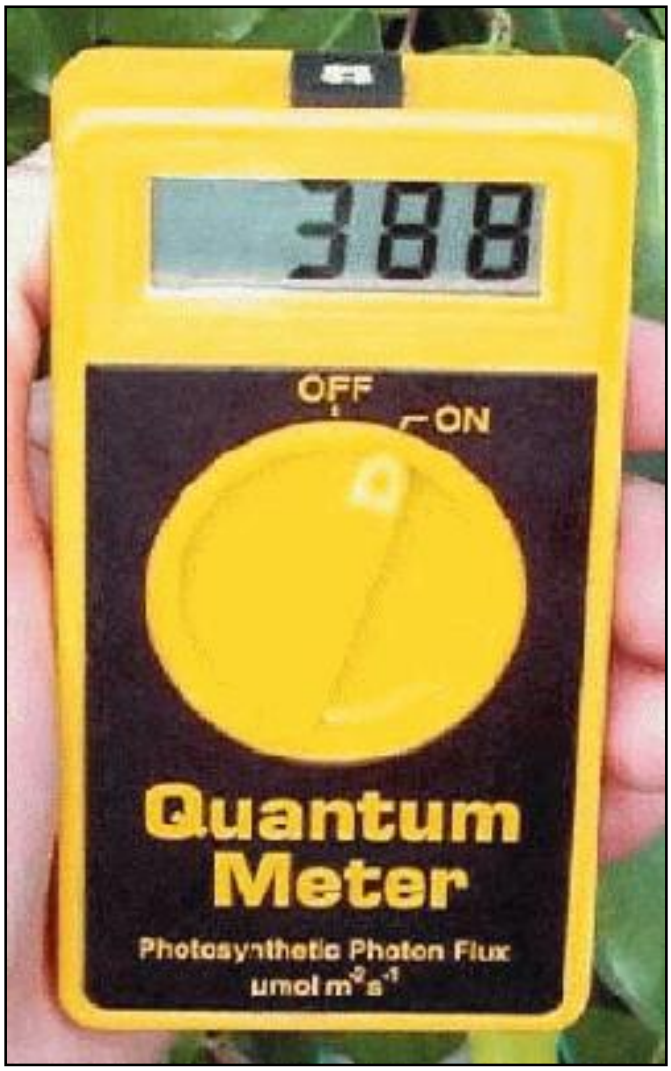
PRODUCT REVIEW RICHARD HARKER

A Quantum Leap in PAR Meters



APOGEE INSTRUMENTS

A hobbyist interested in purchasing a device to measure light levels over his or her tank is faced with a difficult dilemma. Until now, the only choice has been between inexpensive lux meters and considerably more expensive quantum meters. Lux meters are photometric meters. They measure light as the human eye sees it. Because the human eye is more sensitive to terrestrial colors, such as yellow and orange, lux meters give greater weight to light in these wavelengths. The problem is that shorter wavelength colors, such as green and blue, are important for coral zooxanthellae photosynthesis and lux meters give a lower weight to light in this range. From a practical perspective, this means that a lux reading of a blue lamp will be lower than a lux reading of a yellow lamp, even when the blue bulb creates as much photosynthesis in a coral as the yellow bulb.

Lux meters have been popular in the hobby because of cost — they are inexpensive. Those sold to the hobby typically cost a little more than $100, and professional lux meters can be found for a few hundred dollars. For a review of an inexpensive lux meter, see the June 1998 "Product Review" column.

Quantum meters are designed very differently from lux meters. They are designed to measure light as plants use it. Photosynthesis is a quantum reaction. When a photon (a packet of light) strikes a zooxanthellae cell, it produces a photosynthetic reaction. The rate at which this occurs is based on the intensity of the light and the number of photons striking the zooxanthellae, but it is irrespective of the wavelength of the photon or color of the light. Because zooxanthellae can respond to any light between 400 and 700 nanometers (nm), light at every wavelength is equally important for photosynthesis.

Quantum meters are designed to give equal weight to light over the entire range. This is called

"Photosynthetically Active Radiation" (PAR). Given that photosynthesis is a quantum reaction, blue light is just as important as yellow light for a coral. Quantum meters recognize this. Measured in lux, a blue bulb might seem much weaker than a yellow bulb. However, measured with a quantum meter, the two bulbs could produce equal PAR and therefore be of equal value for lighting a reef tank.

The disadvantage of quantum meters has been cost. A basic quantum meter with sensor can cost close to $1000, and the best quantum meters can cost several thousand dollars. Fortunately for the reef hobby, a relatively new company is now producing quantum meters that cost little more than the lux meters currently sold to the hobby. Apogee Instruments, of Logan, Utah, produces a wide range of reasonably priced quantum meters, sensors, and even ultraviolet lightmeters. They even make under water sensors that enable a hobbyist to monitor light levels throughout the tank.

The Apogee Instruments Basic Quantum Meter (BQM) is self contained with a sensor built into a small plastic box with an LCD read-out. While it is the least expensive quantum meter sold by the company, it is also the least practical for use over a reef tank. The sensor must be oriented perpendicularly to the light source. Because the sensor is mounted in the same box with the read-out, the entire unit must be carefully oriented, which is not always practical over a reef tank.

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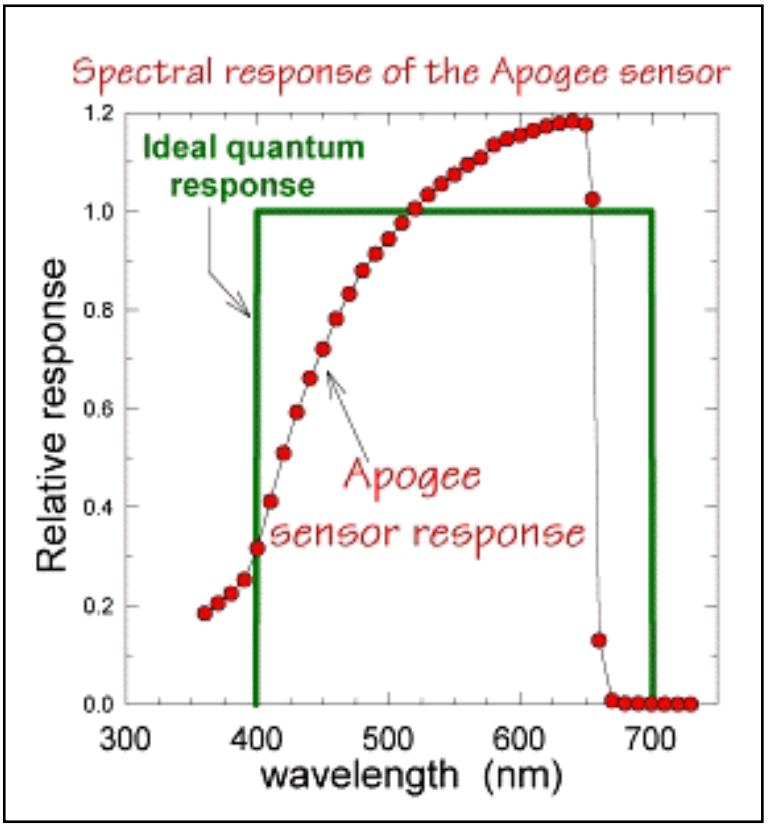
A better choice for a hobbyist is the quantum meter with separate sensor (QMSS). While the unit is more expensive, the added flexibility makes it worthwhile. The small sensor, about the size of a stack of quarters, is linked to the meter with a 2 meter cable. This means the meter can be conveniently held while the sensor is placed under the bulb of interest.

Hobbyists with access to a multimeter have even less expensive options. Apogee Instruments sells quantum sensors that connect to a multimeter capable of measuring in the microVolt range. One of the units is designed for under water use. This means the sensor can be submerged and light levels in the tank continually monitored.

PAR is the most important light related parameter that a hobbyist should monitor, but Apogee Instruments produces other items that might interest the advanced hobbyist. The company sells a UV meter that measures light between 250 and 400 nm. If a hobbyist is concerned about UV emissions, this is one device that can measure it for a fraction of the cost of a professional UV meter. Apogee also sells the UV sensor alone, so one can use a multimeter as a read-out device.

What's the catch?



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When a company like Apogee Instruments sells PAR and UV meters for a fraction of the cost of professional units, there must be a catch. There is. The company reduces costs by using inexpensive plastic housings. The cases are more fragile than professional units designed for field work. In this regard, the compromises are of little consequence. Hobbyist-oriented equipment isn't known for its robust construction anyway.

The units also use inexpensive sensors. This is a more important issue. The ideal PAR sensor measures light between 400 and 700 nm giving exactly even weight to all photons within this range. Real world sensors only approximate the ideal, normally within 5 percent. The Apogee Instrument quantum meter sensors fall well short of laboratory accuracy. They are relatively insensitive to light below 440 nm and overly sensitive to light in the 550 to 650 nm range. They do not measure red light over 650 nm.

The longer wavelength aberrations are of little consequence to hobbyists. The excessive sensitivity in the yellow-orange range is effectively canceled out by the insensitivity to red. The insensitivity to blue is more problematic. Many reef hobbyists use high color temperature blue metal halide bulbs, such as 10,000 and 20,000 Kelvin (K) bulbs. Hobbyists are therefore quite interested in measuring the blue end of the spectrum. Compared to a National Bureau of Standards traceable laboratory quality quantum meter, the Apogee Instruments quantum meters will understate PAR for blue bulbs because of the relative insensitivity to blue. They are, however, far more useful for measuring high color temperature bulbs than a lux meter. Therefore, a hobbyist interested in measuring light over a reef tank should not be discouraged from buying an Apogee Instrument quantum meter because of the sensor limitations.

While the Apogee Instruments quantum meters do a pretty good job of approximating what a laboratory quantum meter would read, the UV meter falls considerably short of laboratory instruments. The UV spectrum is divided into three bands: UV-A, -B and -C. Professional UV meters use separate sensors for each band. The Apogee UV meter uses a single sensor that is most sensitive to UV-A, less so for UV-B and relatively insensitive to UV-C. The UV content of natural sunlight is primarily UV-A, with a much smaller proportion of UV-B and virtually no UV-C (the atmosphere filters out most UV-C and much of the UV-B).

Because the Apogee unit is designed to measure natural sunlight, the designers have chosen the most cost effective means of measuring natural UV emissions, a single sensor most sensitive to UV-A. Metal halide bulbs bear little resemblance to natural sunlight, however. If a hobbyist is concerned about the possibility of unhealthy levels of UV emitted from a metal halide bulb, UV-B and UV-C are of far more concern than UV-A. Therefore, a hobbyist should look at the Apogee unit as only a rough estimator of UV emission.

In conclusion, the Apogee Instrument quantum meters are useful products that can help a hobbyist monitor light levels over a reef tank. While the accuracy of the meters fall short of laboratory quality instruments, they represent a significant improvement over the lux meters currently available to hobbyists.

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