human eye can solve 1′, for a surface with $f/2.5$, the value of $\Delta S \simeq 0.1$ mm, which is an attainable value for a reading scale or micrometer. From the same Eq. (3), we can also observe that the method is less sensitive for bigger f/Nos.

Therefore, the present technique can be used with an existing nodal bench or similar instrument; also a special unit can be constructed for this purpose. The method has important practical characteristics for measurement in a lightened room; the measurement for concave as well as convex surfaces, even positioned in the same platform, can be done without changes. The accuracy is comparable with that of other techniques. The main restrictions are those due to the stability of the setup, values of radii larger than 250 mm cannot be measured, and the minimum diameter of the surface is reached by the beam diameter of the laser. On the other hand, the technique is more sensitive to smaller f/Nos.

This work was presented at the Oct. 1979 Annual Meeting of the Optical Society of America (Rochester, New York) and the Twenty-Second Congreso de Fisica, SMF Nov. 1979 (Monterrey, N. L.).

References

1. R. S. Longhurst, *Geometrical and Physical Optics* (Wiley, New York, 1964), p. 21.
2. Ref. 1, p. 68.

Photometric properties of an unidentified bright object seen off the coast of New Zealand: author's reply to comments

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Maccabee[1] has claimed that conventional sources were ruled out as possible explanations for the observations and filming of a very intense (10^5–10^6-cd) light source from an airplane that was flying east of the South Island of New Zealand on 31 Dec. 1978 between 2:19 a.m. and 2:33 a.m. local time. Ireland and Andrews[2] have suggested that the light actually came from a squid fishing boat that would have been fishing ~60 km north-northeast of Christchurch. In support of this explanation they have pointed out that a large squid fleet was in New Zealand waters at the time and that one of these boats "could have passed the site in question." Their information on the known locations of squid boats (several hundred kilometers east of and several kilometers north and west of the South Island) came from the New Zealand Ministry of Agriculture and Fisheries; these boats also showed up on satellite imagery.[3] Squid boats maintain fixed locations while fishing. According to a more recent paper by Ireland,[4] these locations are reported to the Ministry of Agriculture and Fisheries. However, ministry records failed to show any boats in the vicinity of the sighting area.[4] Furthermore, according to freighter aircraft pilots who have flown over the area in question for many years, squid boats have not been seen fishing in the Pegasus Bay, which is the body of water northeast of Christchurch where the hypothetical boat would have been. Since there is a lack of independent evidence for the existence of a squid boat at the location in question, the proof—or disproof—of the squid boat hypothesis must be based on information collected by the witnesses during the sighting.

When the plane was ~70 km from Christchurch, the pilot turned to the right. According to the witnesses (other than the pilot, who could not see the light from his left-hand seat because the depression angle of the line of sight was too great), the line of sight immediately after the turn was within 20° of straight ahead. Ireland and Andrews claim that the turn angle was ~120° to the right, which would be reasonably consistent with what would be expected if the plane turned toward a stationary light (e.g., squid boat). However, this amount of turning is contradicted by the explicit statement of the captain[3] that he turned from 033 magnetic to 125 magnetic[5] or 92°. The more correct path of the aircraft is illustrated in Fig. 1. The figure illustrates two other modifications[6] in the information of Refs. 1, 2, and 3: (a) the radar detections began within 20 sec of the initial visual sighting, rather than 3 min later as previously reported, and (b) the target went off the aircraft radarscope at ~60° to the right rather than 50° (the 63° angle on Fig. 1 is drawn to the center of the radar blip, estimated to be 6° wide).[7] Figure 1 also illustrates the estimated visual sighting directions after the target went off radar. These directions are estimated from witness statements made during the flight (tape recordings and handwritten notes) and during extensive interviews after the flight.

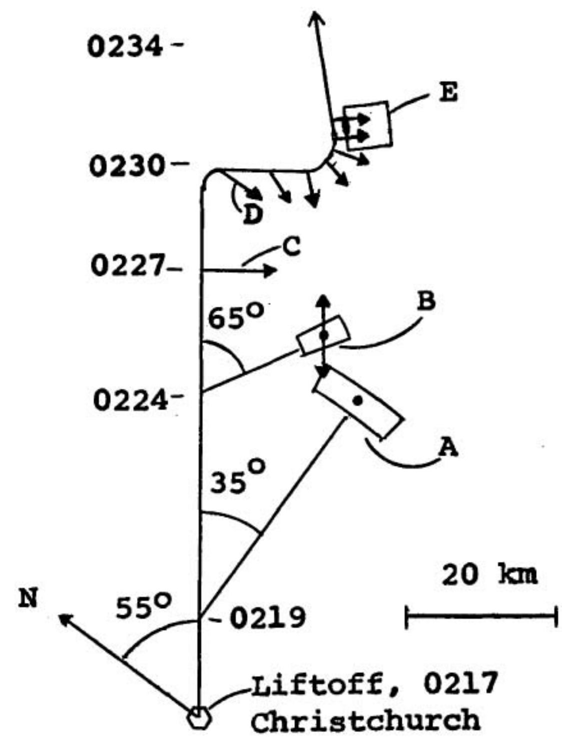

Fig. 1. Approximate flight path of aircraft. Sector A indicates uncertainties in the remembered radar distance and radar/visual azimuth angle when the object was first seen. The vertical arrows through sector B indicate an added uncertainty in the time at which the radar target went off the scope, here estimated to be 5 min after the first sighting. Line C indicates the position of the plane and azimuth of the object as recorded by the Wellington Air Traffic Control Center at 2:27 a.m. Sighting lines D to E are estimates based on witness statements. Associated with these azimuths are depression angles in the range 20–40°, with the depression angle at E being ~45°. The square area at E represents the estimated location of the object when last seen.

Contrary to the stationary squid boat hypothesis, the available data suggest that the light moved a considerable distance during the 13 min or so that it was seen. According to the captain, the radar target moved in toward the center of the radarscope from 33–37 km to 15–22 km at approximately constant azimuth for several minutes, and then the target moved around to the right, disappearing at the limit of the sweep. As nearly as could be determined by the witnesses, the azimuth of the radar target was always the same as that of the light. As the flight continued, the witnesses had the impression that the object paced the aircraft at an apparently constant distance. Immediately after the turn the plane seemed to approach the light, but then it appeared to recede from or avoid the plane and move away and around to the right. There was a very noticeable depression angle in the line of sight after the turn, and there was no radar target, suggesting that the object was below the radar beam.[1] During the subsequent left turn the captain could not see the light directly because it was too far to the right and below his field of view, but he could see the glow in the right-hand windows. He was surprised to see the glow increase in intensity rather than decrease, as he expected would happen if he moved away from the light. A witness also recorded a statement mentioning an apparent increase in brightness during the turn. The light was last seen at the right at a depression angle of ~45° as it appeared to move behind and below the plane. Since the plane was at an altitude of ~3960 m, the light came within ~6000 m of the aircraft.

Because Ireland[4] failed to find a squid boat in the vicinity of the sighting area and because the available evidence indicates that the light source was capable of rather rapid motion (e.g., at least 42 m/sec, 82 knots), it appears that the light did not come from a squid boat. More detailed information on this and other sightings that occurred the same night is available from this author.[8]

References

1. B. S. Maccabee, Appl. Opt. 18, 2527 (1979).
2. W. Ireland and M. K. Andrews, Appl. Opt. 18, 3889 (1979).
3. B. S. Maccabee, "What Really Happened in New Zealand," privately circulated (1979).
4. W. Ireland, "Unfamiliar Observations of Lights in the Night Sky," Physics and Engineering Laboratory Report 659, Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand.
5. These are magnetic compass readings; the magnetic declination is 22° east.
6. The first change corrects a mistake on the part of this investigator: the radar did not require 3 min to warm up after it was turned on because it was already in a warmed-up standby condition, a fact of which I was unaware until after publication of Refs. 1 and 3. The second change results from actual measurements of the radar sweep range. Previously the value had been only estimated.
7. The angular extent of the radar blip reported by the captain was unusually large. Experiments with the same aircraft radar indicate that it can just barely detect individual fishing boats beyond 20 km or so. The associated blips look like small dots on the screen.

8. This research has been supported in part by the Fund for UFO Research, Box 277, Mt. Rainier, Maryland 20822.

Editorial Note: The discussion of this particular incident now seems to be moving outside the realm of technical optics and into areas not relevant to the subject matter of *Applied Optics*. Therefore, publication of this rebuttal will close the discussion.

Modification of integrating sphere accessory to allow spectroscopic measurements of horizontal surfaces from above

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The use of an integrating sphere accessory (ISA) provides significant SNR advantages over most other techniques for the spectral measurement of diffusely reflected or scattered radiation. Unfortunately, commercially available ISAs are designed so that the sample surface must lie in a vertical plane. This design precludes their use with liquids, thick underdense particulates, and many natural surfaces, such as soils, where the nature of the surface would be altered by forming films or pellets, sticking to supports, or embedding in surfaces such as Halon[1] disks. This geometric restriction can be circumvented by the use of two identical light pipes at the sample and reference ports of the ISA, whose functions are to (a) turn the radiation beams through 90° so that the sample and reference surfaces may be in horizontal planes, (b) allow the incident radiation to impinge from above, and (c) return all reflected and scattered radiation to the ISA.

An appropriate pair of light pipes is shown in Fig. 1. They were simply constructed from aluminum cubes by machining two cylindrical holes perpendicular to adjacent cube surfaces. The diameters are slightly less than those of the ISA ports, and the inner surfaces were polished to a mirror finish. The cubes were machined to a plane that contains the intersection of the two cylinders, providing an elliptical opening that was covered with a front-surface mirror that intersects the axes of the two cylinders at 45°. A very narrow shallow flange was formed at the entrance of one cylinder so that the devices can be conveniently and reproducibly located concentric with the axes of the incident radiation; the surface intersected by the other cylindrical hole can be treated for convenient location of the sample and reference surfaces. Because our prime interest is in particulate surfaces related to remote-sensing activities, the sample surface area was prepared to accept 31.7-mm (1 1/4-in.) diam cups sufficiently deep to contain samples thick enough to exceed the optical depth of the ma-

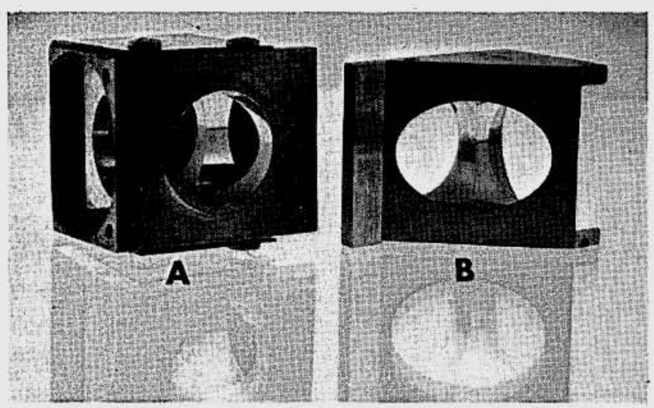

Fig. 1. Two views of the attachments lying on their sides. (A) The entrance–exit port and flange are facing the viewer front-on, the 45° mirror is in place, and the location of the sample cup is seen on the left. (B) The attachment viewed with the front-surface mirror removed. The elliptical opening formed by the intersection of the two cylindrical holes is evident.