8. Fine dust and multiple interference

Content

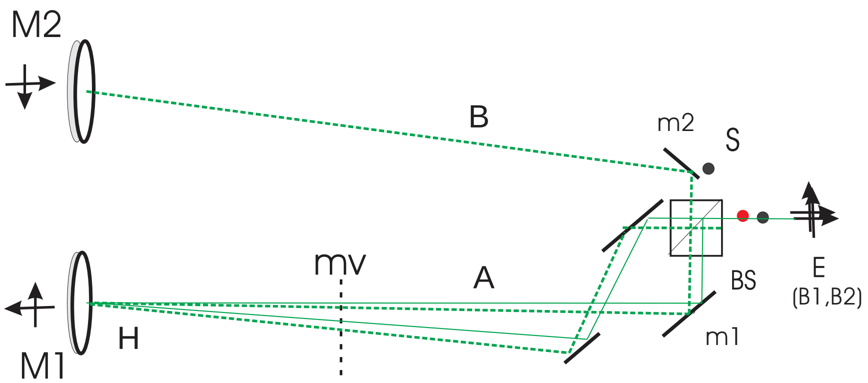
8.1. An arrangement with dual interference.

Next, we wondered if we could make two interferences interfere with each other and what images this would produce. We searched the Internet to see if something similar has ever been done. But perhaps we did not search enough, for we found nothing of the sort.

If we dwell on that thought for a moment, it seems to us that a setup with such double interference will be a lot more difficult to build, but if it succeeds, it may become an exceptionally sensitive instrument. The slightest movement in such a setup will immediately lead to a great color shift and color richness.

So devise and build a setup in which two distinct interferences combine. Not, therefore, two beams of light mixing with each other. But two interferences that we want to let interfere with each other. What shows up we see in the picture below.

Let's look at the drawing below. For simplicity we have only drawn the laser light and left out the diverging and converging beams.

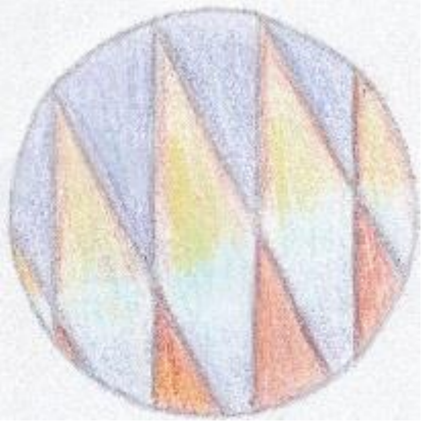


Looking at the system A below, it represents the basic setup with equal light path. The letters mv stand for the small plane mirror. The capital letter H represents the location of the hand just in front of the mirror M1. We rotate M1 slightly so that the reflected light does not reach m1 and Bs in the same place, but a few mm next to it. The outgoing beam to m2 gives an interference image, but because of, we say the non-optimal, non-axial light path, this image gives some interference lines. These can be seen in E, just next to where the laser illuminates the splitter Bs.

However, we are fascinated by the interference light that diverges from m2 to the mirror M2. After reflection, this light goes back converging through m2 to Bs. So all this results in two interferences interfering with each other.

In E, from the splitter, one sees two image points side by side. The first “point,” actually a small plane, shows us the first interference from the basic setup. The second image point, just next to it, and where the laser enters the setup, shows bond the image with the double interference. This image has only half the luminosity of the first image. Understandable, since the light going through the spitter to S is lost to the observer.

If we then look in E to see what shows from the double interference, we see what is shown in the drawing below. We see some vertical interference lines crossed by oblique interference lines. We also see that their colors mix and a nice symmetrical pattern emerges.



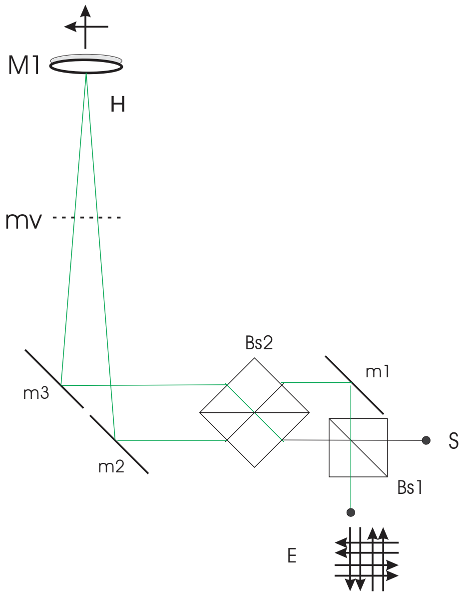
The slightest movement on one of the stellar lines creates yet another kaleidoscopic pattern with a number of other colors. Looking at all these changing colors is fascinating, though. Below, the two interferences run somewhat together. One can see in the bands themselves that discoloration occurs.

If we bring the index finger into the arrangement, virtually no color shifts show up. The setup must be built with greater precision, such that a single mixing color fills the entire mirror surface. We have not been able to achieve that degree of precision.

8.2. An interference of an interference and its reversal.

The setup below also shows us a double one interference. On the right in the drawing we see the vertical bands of interference, but in the background we also see the interference of these bands. Because it is an inversion, the image is not stable.

A perfectly aligned setup would give only a single mixing color and be a hypersensitive setup. But realizing that precision, also because it is a reversal, is not given to an amateur.

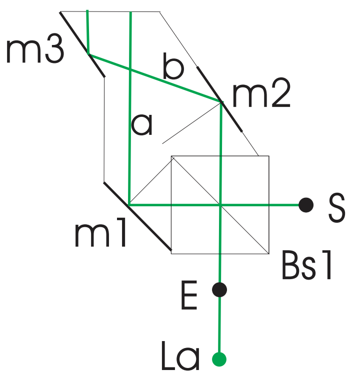


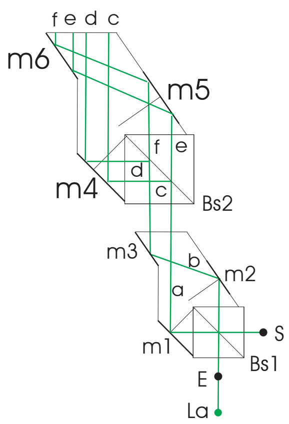
8.3. Some more multiple interferences.

Recall in the drawing below on the left the map from section 6.3. It served there as an "underlay" for the splitter, and this in order to build an arrangement with equal light path. Nothing prevents us from connecting a second card to it. Here we see the splitter Bs2 and the flat mirrors m4, m5 and m6. The light path a we see on it duplicated in the sub-beams c and e, the light path b splits into the sub-beams d and f. These four beams converge on the main mirror. After reflection, the beam f converges into c, and vice versa, and the beam e converges into d and vice versa.

In the splitter Bs2, four beams converge two by two, thus giving rise to two interferences. Finally, these interferences interfere with each other in Bs1. So we see in E a double interference. On the right we see a detail of the setup under construction.

We finished this setup, but kept getting interference lines. We did not manage to adjust them with the required accuracy. Getting about a hundred screws adjusted correctly is no easy task. Again, alignment has to be done with larger flat mirrors in order to adjust everything accurately. In the picture below, only the vertical adjustment screws are in place, the horizontal ones are not yet. These must then be able to push off against a vertically mounted wooden or metal plate, but pulled against it with a rubber band. Quite a job, because each optical component requires three horizontal and three vertical adjustment screws, all drilled out conically and provided with a cone at the bottom. Moreover, when adjusting with the laser, these plates get in the way of the laser light.

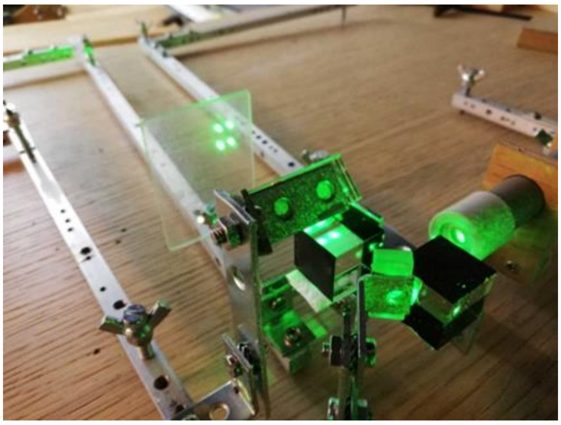




An improved version of the previous setup consists of rotating the second splitter, Bs2, 90 degrees. The partial beams f and e are then not next to the partial beams d and c, but just above them. This makes the parallax smaller.

In the picture below, we have built such an arrangement, but with the basic setup, i.e., with an uneven light path. This setup requires only two plane mirrors and is thus much easier to build. We hoped this would give us very wide interference lines, possibly wide enough to fill the entire mirror surface. But that didn't work out.

The photo does show the light source, the two splitters and both flat mirrors. Just beyond the second splitter, we attached a plastic plate. One can clearly see on this the four laser dots, 2 per 2 above each other. In the previous arrangement we also saw four laser dots, but in a row next to each other. Finally, we note that these last two setups are not reversal interferometers.



After all, many combinations are still possible, but the accuracy required here is no longer a task for an amateur.

We see the ideal multiple interference setup as a highly sensitive instrument. A minimum interference here leads to a maximum shift, either of colors in sufficient light or of shadows becoming visible in more dark illumination. Important here is that the entire mirror surface shows only a single mixing color, or destructive interference. If the mixing color consists of more than one interference, it is obvious that the latter will have a greater sensitivity, and thus - literally - will yield more to the light, or in the other case to the twilight.