How fundamental is Goethe's fundamental phenomenon of colour?

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In the *Kolloquium* of issue 83 of this journal, Florian Theilmann (*Theilmann* 2005) criticizes my article 'Prismatic colours explained with Goethe's fundamental phenomenon' (*Veugelers* 2005). He brings up two objections to show that my arguments are 'not convincing' for him. In his concluding paragraph he even proposes that Goethe's fundamental phenomenon might not be applicable at all to diffraction phenomena. But what use would Goethe's fundamental phenomenon have if it would only be applicable to one kind of phenomenon, i.e. Rayleigh scattering? One could hardly call it a 'fundamental' phenomenon then. In the following I refute Theilmann's objections and show that what I presented in my article is valid, and with it the scope of Goethe's fundamental phenomenon.

Theilmann's first argument touches upon the question what happens if the refraction experiment is done with coloured light. He states (emphasis by F.T.): '[…] what is not to be ignored is that how strongly the bottom is raised and what kind of coloured borders arise depends absolutely on the colour of lighting of the object viewed. If (more or less) spectrally defined lighting is used – for example a sodium vapour lamp – a sharp image *without additional prismatic colours* is obtained'. This argument can be dismissed very simply by asking: what colour would the sunset have if the sun were a sodium vapour lamp? What colour would the sky have? Seemingly Goethe's fundamental phenomenon of colour would not apply in that case. Thus, rejecting my article with this argumentation means nothing less than rejecting Goethe's fundamental phenomenon altogether.

Moreover, the statement that with monochromatic lighting no prismatic colours arise is based on an incomplete observation. Experiments with highly monochromatic red or green laser light show, that red-black or green-black borders seen through a prism indeed do not produce prismatic colours. But in a true Goethean sense one should use this laser light in the complementary experiment as well: looking through a prism to a red-white or green-white border. Then coloured fringes do arise, albeit different from what is observed with black-white borders.

The question of how coloured light influences the arising of colours in refraction experiments (and other light phenomena, for example Rayleigh scattering) comes back to an explanation in Goethean sense of the colouring

of an object. As I stressed in my article, one must abandon the idea that light 'streams' out of a light source. Instead one must consider even a sodium vapour lamp or a laser as a coloured object, be it a gas (plasma), a liquid or a solid. Lighting a white surface, for example a piece of paper, with a coloured lamp means that one sees a coloured object reflected by the paper. And as we do not yet understand in a Goethean sense how light and dark interact to produce the colour of an object, it will be fruitless to try to explain a combined experiment with 'coloured light' refracted by a prism.[1]

In his second argument, Theilmann rejects my observations *and* my mathematical analysis in one stroke by stating that '[…] anyone just standing upright in a pool and observing the form of the pool bottom will find that […] it [the image of the bottom; P.V.] is *never* curved towards the observer'(emphasis by F.T.). To say that something never happens is a claim that is very difficult to maintain. Therefore I assume that Theilmann means here that he himself has not observed such a curving. That may be so, but it leaves untouched the fact that I did see this phenomenon on several occasions in different swimming pools. It must be admitted that this observation is not easy to make. One needs a mirror flat water surface and therefore one should be alone in the pool. Underwater illumination and relatively dark surroundings help to suppress reflections. Also one's eye needs to be very close to the surface. From fig. 1 of my article it can be seen that even with the eye in position 5, i.e. 8 cm above the water surface of a 1.5 m deep pool, the inward curving is relatively small. As it is difficult to accurately estimate distances by sight, certainly with one eye, the inward curving will hardly be discernible. But if one lowers one's eyes to the point where they touch the water (head upright, direction of sight almost horizontal, looking with one or two eyes) the inward curving is unmistakable: the image of the bottom comes racing in towards one's eyes. In a similar way also Theilmann's inability to observe the slanting of the vertical edges of the swimming pool should be attributed to the configuration of his experiments and the limited powers of human sight.

It appears that the model matches my – and many of Theilmann's – observations very well, at least in as much as can be verified qualitatively by sight: the shape of the image of the bottom, the dependence of the height of the eye above the water and the height of the water level, the arising of coloured

1 Working the other way around might prove fruitful though: once a Goethean explanation of prismatic colours is established, looking through a prism to coloured objects would provide information that could help understand the colouring of objects in a Goethean sense.