Digital holographic microscopy – a unique tool for the marine sciences

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Digital holographic microscopy (DHM) is so far mostly applied in the fields of material and life sciences, but in fact shows promising applications in the marine world. Holographic microscopy provides quantitative information on the optical thickness of a sample and thus unique insights to cell characteristics. What if you have three small plankton cells which through a standard light microscope look the same, i.e. they have the same green colour and the same size? How can you differentiate them? With DHM you obtain additional information, so-called phase information, which is more specific to each cell in the sense of a 'holographic fingerprint', which allows you to differentiate cells more successfully (Zetsche *et al.*, 2014). It can thus be used to improve the classification of nanoplankton, but can also improve the determination of live *versus* dead cells, or simply provides other detailed information on cell morphology, characteristics and interactions. DHM allows us to observe marine organisms and their interactions with the environment in a non-invasive manner, without the need for staining but with the ability to follow dynamic processes over time. Since it allows us to capture phase information, substances of a different refractive index to the surrounding medium may also be captured, extending the range of experimental subjects to transparent substances such as polymeric and mucoid substances. These substances remain normally 'invisible' to a standard light microscope but are an important component of organic matter found in the oceans. We have successfully observed, for example, the extracellular polymeric substances released by algal cells creating a biofilm surrounding the cells, the mucus released by the cold-water coral *Lophelia pertusa* in vivo, and also other sugar- and protein-containing substances binding together marine snow aggregates. The applicability of DHM to the marine sciences is thus very diverse and promising, and warrants increased awareness among the scientific community for the existence of this unique tool.

References

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