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Project title: Structured colours with transition-metal dichalcogenide (TMD) nanostructures	
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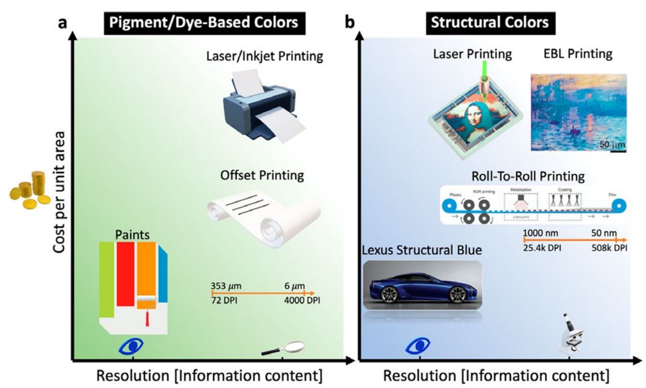
PROJECT DESCRIPTION:

Structural colours promise an efficient alternative to current colouration techniques based on organic dyes or heavy-metal-doped pigments [1-3]. The former have a limited lifetime after which they eventually fade, while the latter might be toxic and dangerous to consumers. To generate long-lasting, consumer-safe paints, structural colours can be used, based on the optical response of a nanostructured system, where incident light can be scattered, absorbed, and diffracted at specific wavelengths. This approach has been used—without understanding the mechanisms involved—already since ancient times, when metallic nanoparticles sustaining collective electron oscillations (now known as plasmons) were used in cups, glasses, and church windows [4]. A great deal of current research activities concerns alternative templates for structured colours, with engineering possibilities being related to the size, material, and periodicity of the building blocks. From plasmonic systems shift is gradually shifting towards dielectrics: either with a high refractive index, in which case it is Mie resonances that generate the colour [5], or with lower-index polymers (often 3D-printed), where diffraction and waveguided modes are responsible [6].



The aim of this project is to explore, numerically, the colouring possibilities offered by transition-metal dichalcogenides (TMDs), either in the form of patterned monolayers or in arrays of larger nanoparticles [7,8], where excitonic transitions and self-hybridisations might play a role. The project will start with the study of single TMD nanospheres, first analytically within Mie theory (knowledge of a programming language, e.g. **Fortran, C++, Matlab** required), and then numerically, with a commercial finite-element method (**Comsol**), with the aim to proceed to periodic structures of such NPs and explore the roles of size and periodicity, while understanding all the different physical mechanisms responsible for the final colour.

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[3] S. D. Rezaei et al. – ACS Phot. **8**, 18 (2020).
[4] F. Dekker et al. – Chem. Teach. Intl. **3**, 20190011 (2020).
[5] A. Dorodnyy et al. – Laser Photon. Rev. **17**, 2300055 (2023).
[6] H. Wang et al. – Nano Lett. **21**, 4721 (2021).
[7] Y. Sun et a. – Acc. Chem. Res. **54**, 1517 (2021).
[8] B. Munkhbat et al. – Laser Photon. Rev. **17**, 2200057 (2023).