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Lightwave topology for strong-field valleytronics ALVARO JIMENEZ-GALAN, Max Born Institute, RUI SILVA, Universidad Autnoma de Madrid, OLGA SMIRNOVA, MISHA IVANOV, Max Born Institute — Modern light generation technology offers extraordinary capabilities for sculpting light pulses, with full control over individual electric field oscillations within each laser cycle. These capabilities are at the core of lightwave electronics – the dream of ultrafast lightwave control over electron dynamics in solids, on a few-cycle to sub-cycle timescale, aiming at information processing at tera-Hertz to peta-Hertz rates. At the same time, quantum materials have opened the way to dissipationless electron transport and to the possibility to harness extra electronic degrees of freedom, such as the valley pseudospin, that can be used as additional information carriers. Im this talk, I will merge these two fields, and show a robust and general approach to ultrafast, valley-selective electron excitations in two-dimensional materials by controlling the sub-cycle structure of non-resonant driving fields at a few-femtosecond timescale. Bringing the frequency-domain concept of topological Floquet systems to the few-femtosecond time domain, I will demonstrate a transparent control mechanism in real space to induce and control topological properties on topologically-trivial monolayers, and an all-optical, non-element-specific method to coherently write, manipulate and read selective valley excitations using fields carried in a wide range of frequencies, on timescales orders of magnitude shorter than valley lifetime, crucial for implementation of valleytronic devices.

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