POPULAR SCIENCE SUMMARY

1. State of the art: In the last few years, increasing numbers of cybercrimes correlated with a lack of privacy started to appear due to the development of Information Technology. Modern data storage and safety require digital signatures that rely mostly on high-quality Random Number Generators, which constantly motivate Researchers across the world to find more sophisticated methods to create Random Numbers (RNs). The desired property of RNs is their unpredictability; thus, finding an algorithm that can predict future numbers based on these already generated data is almost impossible. Random Numbers are constantly utilized in many different fields, such as financial institutions, gambling, or the creation of random passwords. Moreover, they are crucial to developing areas like cybersecurity or cryptography. One of the recently proposed solutions to generate RNs is to apply a photonic process, such as photon round trip time in semiconductor lasers. However, the external cavity and its proper design limit the usefulness of this device in different fields. In Random Lasers (RL), the optical feedback is provided by multiple light scatters, consequently creating static or dynamic disorder, depending on the gain material. If we consider the liquid solution of the laser dye, the Aggregation-Induced Emission appears to be perfectly suitable for lasing purposes due to its possibility of supporting both light amplification and multiple scattering.

2. Objective: The main aim of this grant proposal is to generation random numbers from organic laser dyes exhibiting dual emission in scattering media. We aim to compare the static disorder obtained in thin polymer films with the dynamic distribution of scatterers in liquid samples. Therefore, we want to test that dynamic disorder can be far superior in random number generation from static disorder as all of the available RL quasimodes will always alter between each consecutive laser pulse. In other words, there will not be any particular frequencies where probabilities will dominate others, resulting from a clearly defined and time-constant structure responsible for light scattering.

3. Significance of the project: The outcomes of this project can significantly impact our understanding of how the observed modes in random lasers can contribute to the generation of randomness within the scattering media obtained due to the aggregation process. The randomness of the RL generated by bichromatic laser emission gives exchange the traditional method to create RNGs based on pseudo-random algorithm. Thus, in brief, this project will potentially have a considerable contribution to the development of the field of science, whereas RNGs are crucial and cannot be replaced.

4. Project description: The project has an experimental character focused on exploring the photophysical properties of organic dyes. We plan to determine the statistics of random mode intensities and spectral positions in order to evaluate their usefulness in random number generation. We will compare how it differs from statistics obtained for samples with static disorder. We are going to investigate if dual-band emitters can be used to tune the statistics of generated random numbers and how we can control them. Typical statistical analysis, including proper statistical modelling, will be conducted as a contribution to the mentioned tasks.