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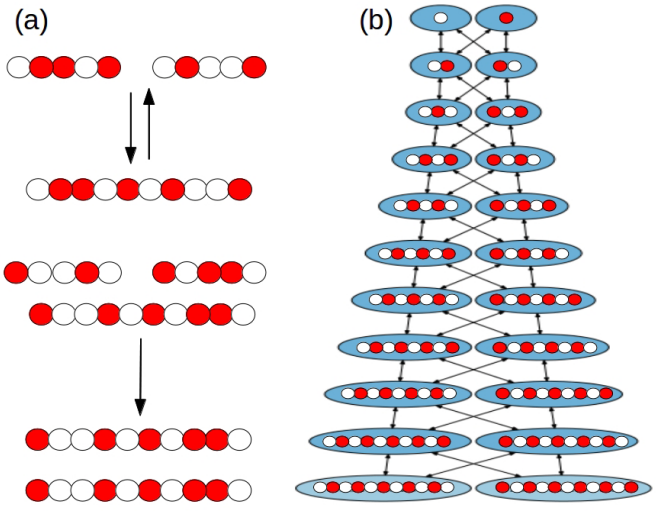
Highlights from the previous volumes

Structure and selection in an autocatalytic binary polymer model

Template directed replication of information in polymers is at the essence of living beings, and is believed to be a cornerstone of life's origin. Using a binary polymer model, where polymers act as templates for their autocatalytic replication, we analyze the chemical reaction network in which replicators serve as reactants of each other and compete for common resources. The involved random ligation, degradation and autocatalytic replication reactions are shown in panel (a) of the figure below. Our idealized model demonstrates how autocatalysis in such a molecular ecology completely alters the qualitative and quantitative system dynamics in counterintuitive ways. We demonstrate analytically that the system features a stationary state where the concentration of polymers does not decrease with length. Numerical simulations reveal a strong intrinsic selection mechanism that favors the appearance of few population structures with highly ordered sequence patterns when starting from a pool of monomers. An example of such a cooperative structure is shown in panel (b) of the figure below. This selection mechanism is due to symmetries in the underlying reaction network, and we discuss how these intrinsically selected species might be in line or in conflict with other prebiotic selection mechanisms.

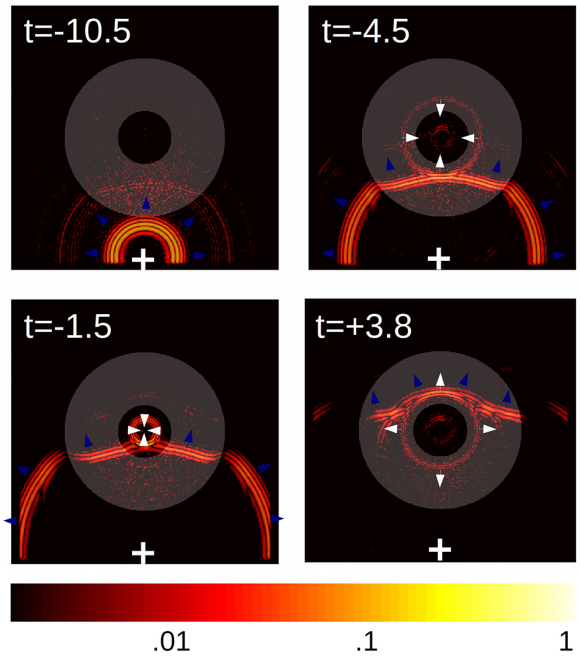


(a) The reaction scheme. (b) A typical reaction network.

Original article by Tanaka Shinpei *et al.*
EPL, **107** (2014) 28004

Green's function retrieval and fluctuations of cross density of states in multiple-scattering media

Random noise is generally a nightmare for active imaging. But in passive imaging, however, one can take advantage of random wavefields to retrieve information about the propagation within the medium. When sufficient uncorrelated noise sources are spatially distributed, the cross-correlation of signals recorded at two receivers indeed provides a direct estimation of the medium transient response as if one of the receivers had been replaced by a pulse emitter. This property is valid not only in homogenous media but also in disordered media. This method has paved the way for passive imaging in helioseismology, seismology or acoustics. In this paper published in *EPL*, we show that, in a multiple-scattering medium, scatterers play the role of secondary sources and increase the randomess of the wavefield. We also show that fluctuations of the estimated transient response are governed by non-Gaussian statistics. This result is not only important for passive volcano monitoring or structural health monitoring but also for material science.



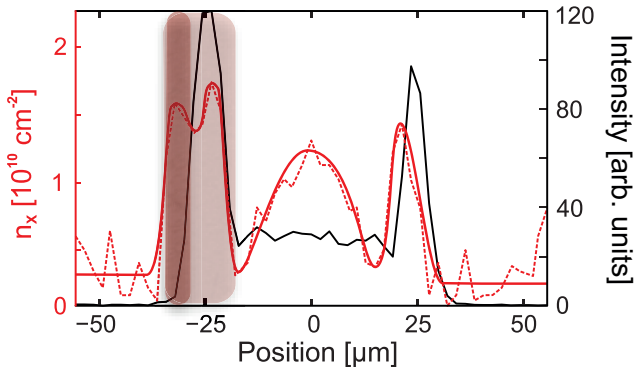
Mean cross-correlation maps at four different times t in a multiple-scattering medium (shown in grey). The noise is emitted by a single source (white cross). The extracted wavefront is highlighted with the white arrows.

Original article by de Rosny Julien and Davy Matthieu
EPL, **106** (2014) 54004

Evidence for a Bose-Einstein condensate of excitons

At sufficiently low temperatures, boson-like quantum particles can condense in the ground-state of the system and then form a particular realm called Bose-Einstein condensate. Semiconductor excitons, *i.e.* electron-hole pairs bound by Coulomb attraction, shall undergo Bose-Einstein condensation under *a priori* easily accessible experimental conditions, *e.g.* below a few kelvins. However, due to their composite nature, excitons exhibit a dark ground state, *i.e.* optically inactive, which has certainly contributed to the lack of signature of exciton condensation obtained through conventional optical probes.

In this letter, the authors reveal the dark nature of excitons Bose-Einstein condensation. They report an excitonic quantum statistical distribution marked by a dominant ($\sim 90\%$) fraction of dark excitons at sub-kelvin temperatures. The exciton condensate emits a weak photoluminescence with macroscopic spatial coherence and linear polarization. These signal a multi-component exciton condensation, with a weak bright component coherently coupled to a dominant dark part, as theoretically predicted.



Profiles of the photoluminescence intensity (black) and exciton density, n_X (red), at 350 mK in a spontaneously formed electrostatic trap (shaded area). Quantum statistics is signaled by the large density combined to an anomalously weak photoluminescence (darker shaded area).

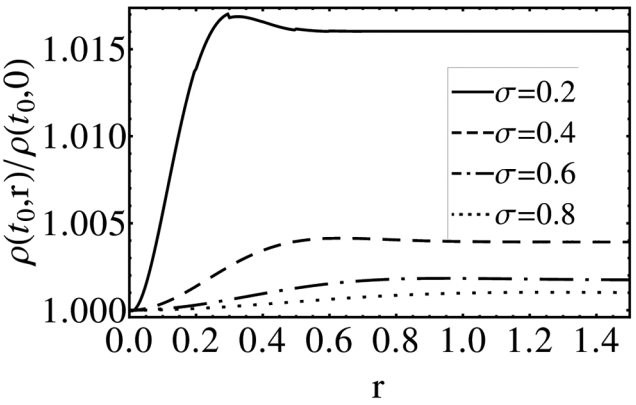
Original article by Alloing Mathieu *et al.*
EPL, **107** (2014) 10012

Non-perturbative effects of primordial curvature perturbations on the apparent value of a cosmological constant

The standard cosmological model is based on the assumption that the Universe is homogeneous and isotropic on a sufficiently large scale. Inflation can give a natural explanation to this large-scale homogeneity, through a sufficiently long period of exponential expansion of the Universe, but it also predicts the existence of perturbations of the metric, which are in good agreement with the observed anisotropy of the cosmic microwave background radiation or the large structure of the spatial distribution of galaxies.

This is the motivation to study the effects on the luminosity distance of a local inhomogeneity seeded by primordial curvature perturbations of the type predicted by the inflationary scenario. We find that a local underdensity originated from a one, two or three standard deviations peaks of the primordial curvature perturbations field can induce corrections to the value of a cosmological constant of the order of 0.6%, 1%, 1.5%, respectively.

Our results can be considered an upper bound for the effect of the monopole component of the local non-linear structure which can arise from primordial curvature perturbations and requires a fully non-perturbative relativistic treatment.



Examples of density profiles seeded by primordial curvature perturbations modeled by Gaussian curves of different width.

Original article by Romano Antonio Enea *et al.*
EPL, **106** (2014) 69002