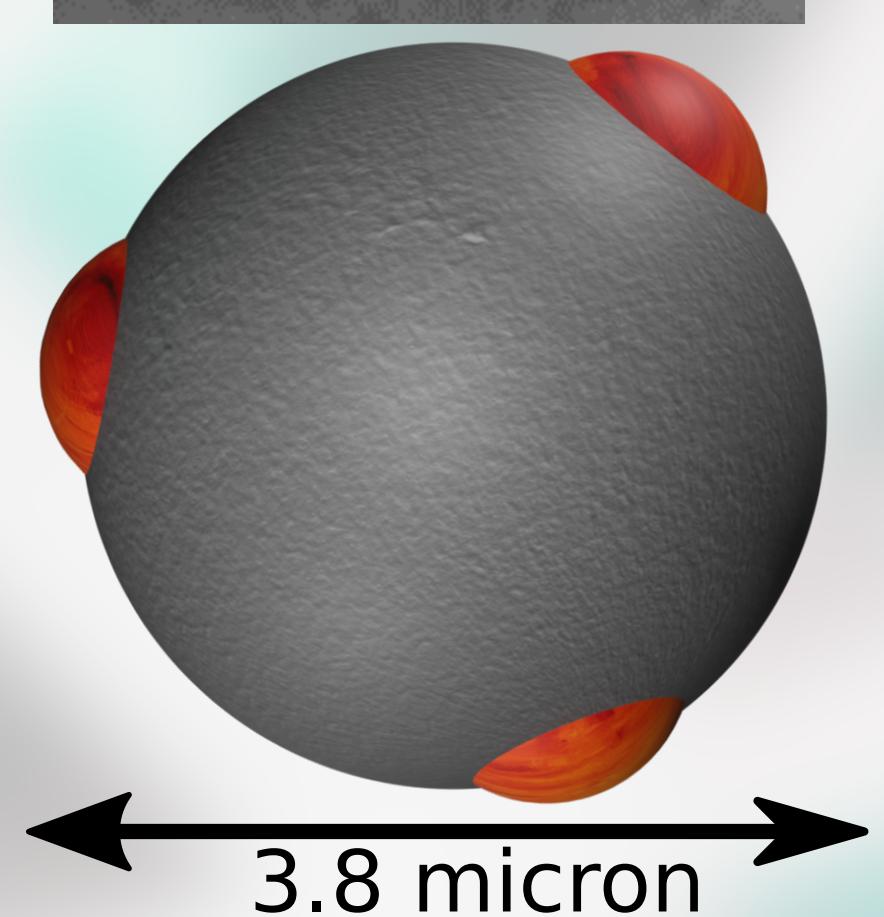
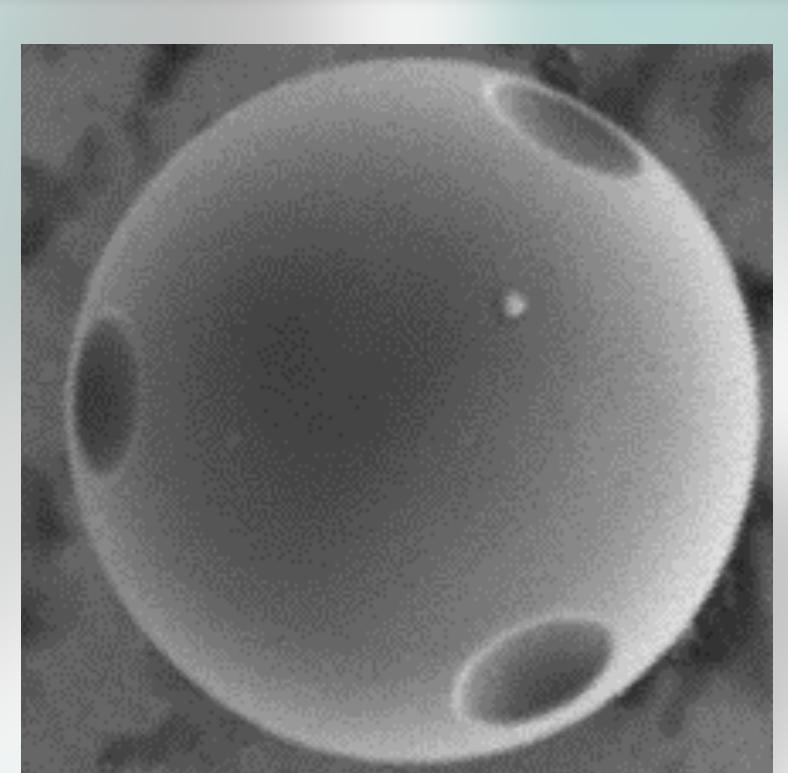


# Colloidal Molecules: Assembling Patchy Particles into Colloidal Superstructures

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Molecular assembly is a good inspiration for the design of colloids for complex superstructures. From simple atomic properties, like direction, valency and reversibility, atoms can spontaneously form many different structures, from rings to polymers, and from diamond crystals to glasses. The reverse is also true: the assembly of colloids with atom-like properties may grant us new insight into the behaviour of molecules.

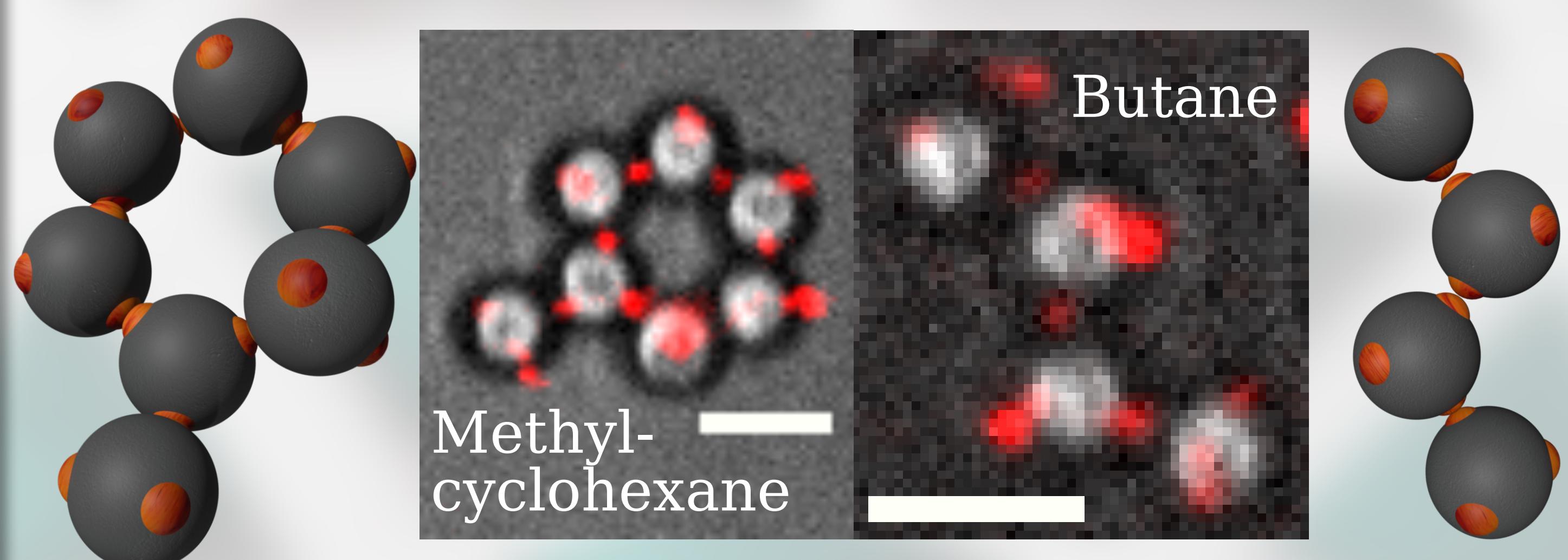
## I. Colloids and Casimir



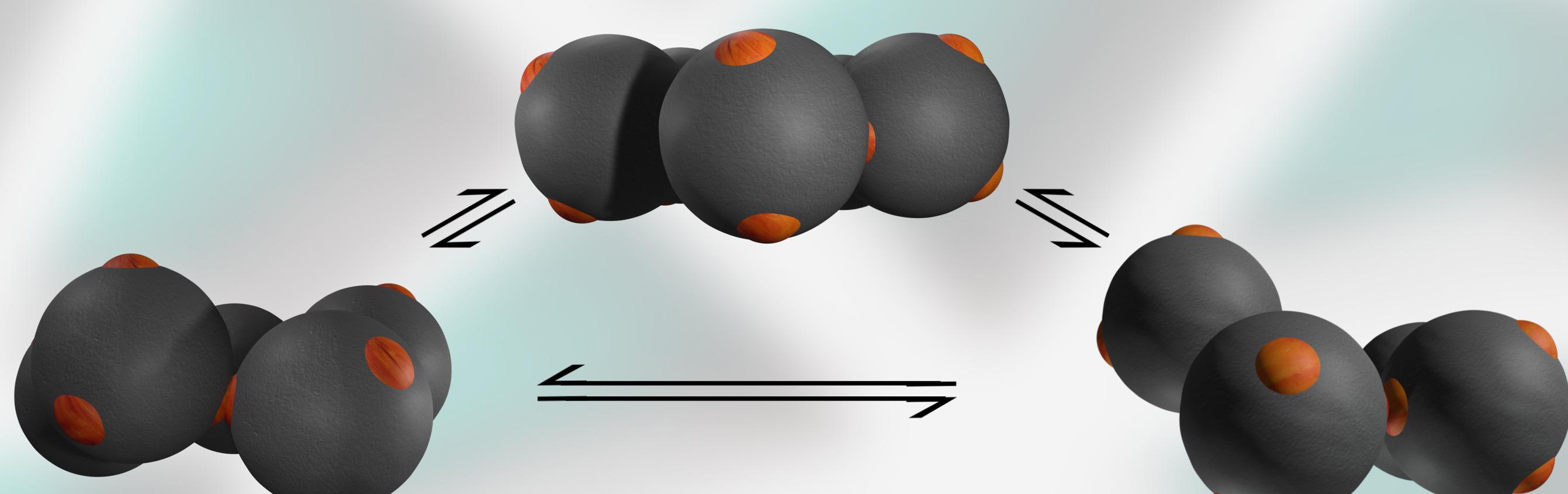
The group of Sacanna (NYU) has perfected the synthesis of monodisperse anisotropic colloidal particles with discrete patches. Using critical casimir forces, we make patches on the particles attractive. Computer simulations have revealed a wealth of structures that result from the assembly of patchy particles as a function of the main tuning parameters – the number of patches per particle, the patch size, and the particle geometry.

## 2. Colloidal Molecules

By taking tetrapatch particles and making the patches attractive, structures will spontaneously assemble. Many of the structures bear a strong resemblance to molecules. By tracking each particle and its patches in 3D, we can easily study the behaviour of these "colloidal molecules".

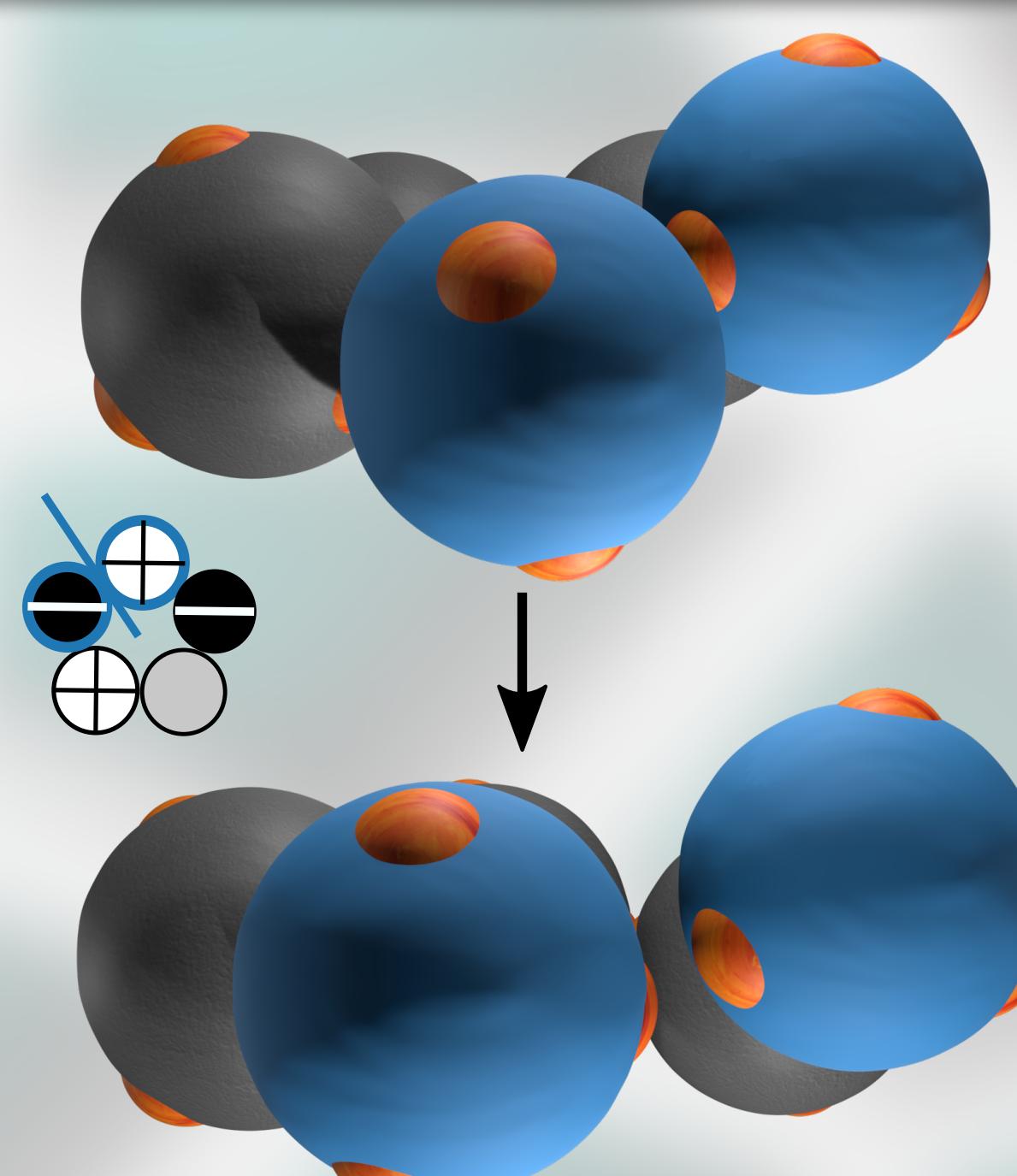


## 3. Conformations and Dynamics



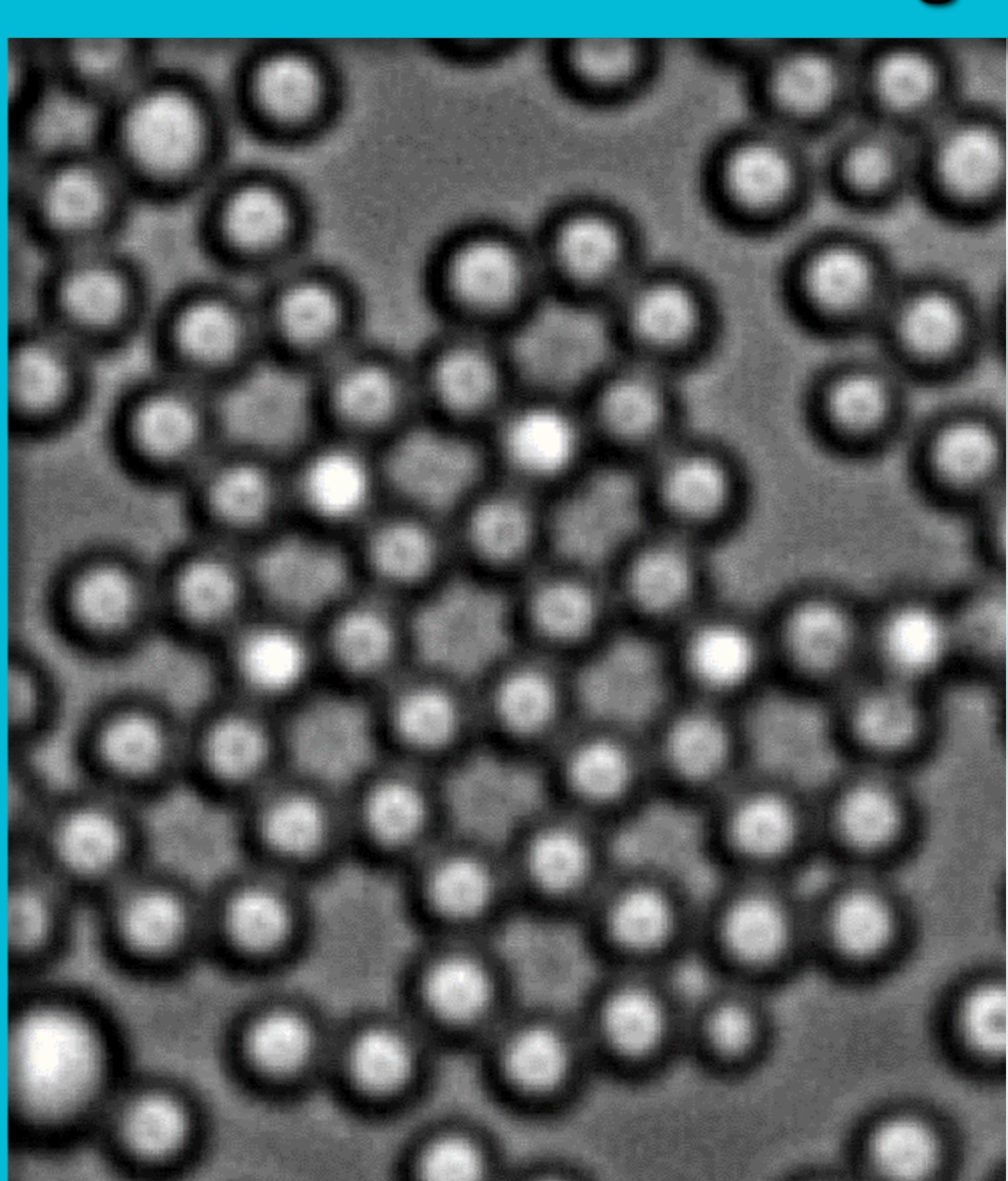
We take cyclopentane as an example to study colloidal molecules. We observe the rings are not planar, as you may expect, but puckered, particles moving up and down of the plane. This puckering is also observed in "atomic" molecules, but the puckering of colloidal molecules is much easier to study!

## 4. Breaking the Ring - a Colloidal



Using the information from the particle positions, we can predict when and where the ring will break. Insight in (colloidal) reaction mechanics is interesting in the light of catalyst design.

## 5. Building Materials



Colloidal molecules are not the only thing that we can build. Using pseudo-tripatch particles, we see large, 2D crystalline layers exhibiting a graphene like-structure. Again, we can easily study the colloidal structure, while the atomic counterpart is hard to study at such level of detail!

## Conclusion

- Patchy particles interacting by critical Casimir forces can be used to build a wide range of colloidal molecules
- Direct, real-space observations of colloidal cyclopentane allow insight into transition states and reactions its atomic counterpart
- We are actively pursuing building larger structures.
- This work serves as a starting point for even more complex colloidal structures