Choose one of the topics below and write a 1000 word paper (in english) to discuss the question. The topic can not be the same you had for your presentation. Your answer must be supported with experimental and/or theoretical work from published papers that must be properly cited. Your paper will be graded according to

- structure and form (taking into account that most of you are not native-english speakers),
- clarity of the argumentation, and
- scientific soundness of the answer, i.e. how it is supported by published results. In some cases there may not be one correct answer, in which case you should discuss the different possibilities. Also here, base yourself on published work.
- Some of the questions relate do topics discussed in class. This will be taken into account.

You must inform me which of the topics you choose, the latest by the 1. June. You can change your selection until the submission date, but you need to inform me about any such change. Your choice needs to be approved by me, and I retain the right to deny your choice if, for example, the topic is too close to your talk, or if someone else has chosen the same topic.

The papers are due on the 4.7. at 23:59h, to be submitted (as a pdf smaller than 100 MB) via moodle, where your papers will be checked against plagiarism. Do not plagiarise… Also, do not ask ChatGPT to write your paper.
That said, I do encourage you to discuss your paper with your colleagues, as long as in the end you write your own text.

	Methods in Spectroscopy and Dynamics, 2025
1	Gas-surface scattering - we can classify chemical processes in pure gas-phase reactions, reactions in the liquid phase, or reactions go species, liquid or gaseous, at the interface with a liquid or a solid. Explain methods to fundamentally study gas-solid surface chemistry basing on the interaction of molecular beams with solid surfaces. How is this done and what can be learned from such studies?
2	We have discussed in class different methods to study the structure of neutral molecules spectroscopically. How is this adapted to large bimolecular ions in the gas-phase? In particular, such ions yield broad unresolved spectra at room temperature and must thus be cooled. Describe existing methods to solve this issue and what information has been obtained from spectroscopic studies of charged biomolecules.
3	The chemistry on and in aerosols is important in atmospheric chemistry but also in physiological environments. Explain how we can fundamentally study the dynamics on and in aerosol droplets, how such studies are performed and what we can lear from them.
4	We have seen in class a method to study ion-molecule chemistry using Coulomb Crystals (class by Prof. Willitsch). Explain how a molecular-beams approach can be used to study such reactions, and what we learn from them. Compare this approach to the use of Coulomb crystals.
5	Gas-phase chemistry is of importance in particular in interstellar space. Describe the type of chemistry that can happen in that environment and what are the characteristics of this environment with relevance to chemistry. What are bigopen questions in interstellar chemistry?
6	Explain the difficulty in observing a bimolecular chemical reaction as a function of time at the molecular level. I.e. why do we not have “movies” of the reactions you are studying in organic chemistry?
7	A recent development in laser physics was the ability to produce attosecond laser pulses. Explain how this works and what it can be used for.
8	Studies of large molecules in the gas phase are often difficult because the molecules exist in different conformations. Explain how charged (bio-)molecules (i.e. proteins or glycans) can be separated by their conformation and what such a technology is being used for.
9	Gas-liquid scattering - we can classify chemical processes in pure gas-phase reactions, reactions in the liquid phase, or reactions go species, liquid or gaseous, at the interface with a liquid or a solid. Explain methods to fundamentally study gas-liquid interface chemistry basing on the interaction of molecular beams with liquid interfaces. How is this done, what are the challenges and what can be learned from such studies? How are such studies performed on volatile liquids, and why are such experiments challenging?
10	Charged particles can be stored in storage rings, as they are used for example at CERN. Discuss possibilities to also do this with neutral molecules, explain how this is done and experiments that show it. (Hint: work by Gerard Meijer et al.)
11	Assume you would like to know the precise rotational state in which a reaction product BC from the gas-phase reaction AB+C->A+BC is formed, as a function of the reaction conditions. How would you measure that?
12	Frequency combs are a special form of operation of lasers. Explain what they are, how they are generated, and what they are used for. In particular, discuss their use in spectroscopy.
13	Radicals and ions seem to play an important role in atmospheric chemistry. Explain the scientific reasoning behind this assumption and how we can experimentally test it. Which techniques exist for such studies?
14	Compare methods for molecular structure determination by X-Ray diffraction, electron microscopy and NMR. Which method would you use in which context?