



EINLADUNG

zum Vortrag von

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Cracking the New-Particle Puzzle: Lessons from Megacities for Future Urban Air

am Dienstag, 2. Dezember 2025, um 18 Uhr

Ort: Lise-Meitner-Hörsaal, Fakultät für Physik, Universität Wien,

1090 Wien, Strudlhofgasse 4 / Boltzmannngasse 5, 1. Stock

Barrierefreier Zugang: Boltzmannngasse 5, Lift, 1. Stock rechts über den Gang zum Hintereingang des Hörsaals

New particle formation (NPF) from gas-phase precursors plays a crucial role in the Earth's atmosphere and remains a major source of uncertainty in climate projections. During NPF, volatile gases undergo atmospheric oxidation to form less-volatile products that assemble into molecular clusters and eventually a new phase—an archetypal problem in chemical physics. Under typical conditions, NPF is favored by moderate temperatures, clear skies, and low background aerosol concentrations.

This understanding was challenged by the surprising discovery of frequent NPF events in Asian megacities, where pre-existing aerosol loadings appear far too high for nanoclusters to grow before being scavenged. The microphysical processes and chemical reactions enabling NPF under such conditions were unknown, leaving its contribution to severe urban pollution unresolved. These findings also force us to rethink air quality in the city of the future, where we expect lower background aerosol concentrations but continued—and potentially changing—gas-phase precursor emissions.

Here, we show how nanoparticle growth can be enhanced in both present-day and future urban atmospheres, enabling nanoclusters to survive long enough to explain NPF in heavily polluted environments as well as in cleaner, next-generation cities. We summarize the suite of experimental, analytical, and modeling tools we have developed to address this problem. Advances in instrumentation and data processing have reduced major uncertainties in number-size-distribution measurements and growth-rate estimates. In parallel, refined growth models now better capture the chemically diverse set of condensable vapors in urban air, leading to a more complete picture of nanoparticle survival.

Our results demonstrate that NPF plays a decisive role in megacity air quality and is likely to become even more important in future urban environments. Remarkably, nanoparticles often grow at unexpectedly steady rates even when no NPF event is observed. We now show that population dynamics themselves promote nanoparticle survival by enhancing the uptake of the diverse organic vapors characteristic of urban atmospheres. The “unique atmospheric experiment” provided by the Covid-19 lockdowns further revealed the sensitivity of urban atmospheric chemistry—especially NPF—to changes in emissions. This is highly relevant for future cities, where organic emissions may increasingly stem from consumer products with strong NPF potential.

Taken together, these findings highlight the scientific challenges in fully understanding atmospheric phase transitions. Solving them requires insights from across the chemical-physics community, far beyond the traditional atmospheric sciences.

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