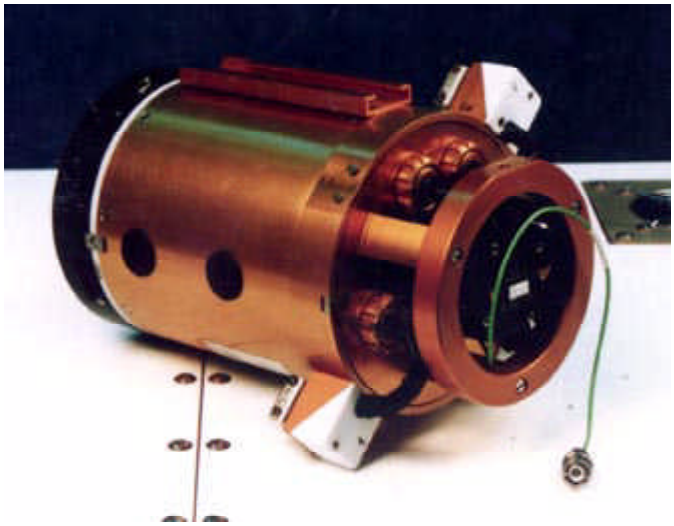
Growth and Morphology of Supercritical Fluids Studied in Microgravity on Mir

The Growth and Morphology of Supercritical Fluids (GMSF) is an international experiment facilitated by the NASA Glenn Research Center at Lewis Field and under the guidance of U.S. principal investigator Professor John Hegseth of the University of New Orleans and three French coinvestigators—Daniel Beysens, Yves Garrabos, and Carole Chabot. In early 1999, GMSF experiments were operated for 20 days on the Russian Space Station Mir. Mir astronauts performed experiments One through Seven, which spanned the three science themes of near-critical phase separation rates, interface dynamics in near-critical boiling, and measurement of the spectrum of density fluctuation length scales very close to the critical point. The fluids used were pure CO_2 or SF_6. Three of the five thermostats used could adjust the sample volume with the scheduled crew time. Such a volume adjustment enabled variable sample densities around the critical density as well as pressure steps (as distinct from the usual temperature steps) to be applied to the sample.

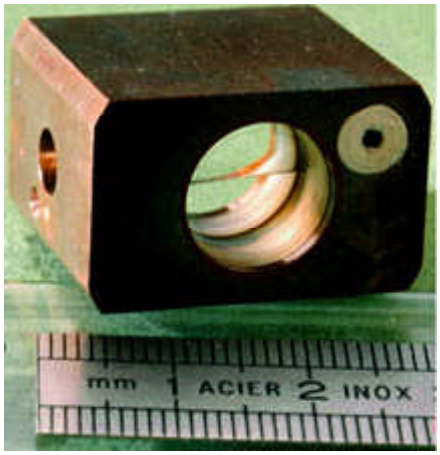


ALICE II thermostat for critical fluid samples. It enables stable temperature control (±50 m°C rms) and optical diagnostics like interferometry and microscopy.

The French-built ALICE II facility was used for these experiments. It allows tightly thermostated (first photograph) samples (second photograph) to be controlled, viewed, and measured. Its diagnostics include interferometry, shadow graph, high-speed pressure measurements, and microscopy. Data were logged onto computer DAT tapes and PCMCIA cards and were returned to Earth only after the mission was over.

The near-critical boiling experiment worked well and produced different liquid-vapor interface dynamics than previous low-gravity results. This was due to the bubble locating with different thermal boundary conditions for the two missions. The density fluctuation spectrum experiment did not perform well because of a hardware problem and the inability

of Earth-based researchers to detect and interact with the hardware onboard Mir. The phase-separation experiments were the most successful. These required the greatest amount of data reduction, which is still in progress. The second 20 days of experiments that had been planned were cancelled when the U.S. support of Mir expired.



Typical copper-bodied cell with sapphire windows. It is filled with SF_6 to roughly 38 atm and a density of 0.73 g/cm^3. The typical fluid volume was less than 1 cm^3.

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