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Annotated Bibliography

Cho, A. Y., Wuencher, H. F., Melfi, L. T., Hueser, J. E., Naumann, R. J., & Ignatiev, A. (2001a, November 8). *Wake vacuum measurement and analysis for The wake shield facility free flying platform*. Vacuum. https://www.sciencedirect.com/science/article/abs/pii/S0042207X01003839

Summary
Strozier et al. report the first in orbit pressure, and temperature measurements taken on NASA's 12-ft Wake Shield Facility (WSF) during its 1995–96 free-flight missions (STS-69 and STS-80). The WSF disk was designed to exploit the ultra-high vacuum expected in the aerodynamic "wake" behind a spacecraft for Molecular Beam Epitaxy (MBE) film growth. Using four cold cathode gauges and distributed thermostats, the team were able to log 1,000+ pressure points per 94-min orbit on both the ram and wake sides. Monte-Carlo models had predicted a six-order (10^-8 →10^-14 Torr) pressure drop in the wake.
However, in practice they were only able to observe a two order reduction, accompanied by large, orbit-scale (~100×) diurnal swings that peaked at orbital sunset. The authors attribute the shortfall to solar-driven thermal desorption of water from stainless-steel surfaces and to internal outgassing of the gauges themselves. These effects were amplified when Ga from an over heated source cell coated the chassis on the second flight. Ram side data, by contrast, tracked the Jacchia (1970) thermospheric density model, validating that model experimentally for the first time. A thermal desorption model combining geometry factors and temperature dependent outgassing rates reproduced both the DC wake pressure and the phase-shifted oscillation, and suggested that, with thorough pre-flight degassing (<3 × 10^7 molecules cm^-2 s^-1), pressures near 10^-14 Torr remain achievable.
Credibility
The article appears in *Vacuum* (Elsevier, 2002), a peer reviewed journal specialising in surface science and low-pressure technology. The lead author team comes from the University of Houston's Space Vacuum Epitaxy Center, the group that conceived and flew the WSF, giving them first-hand access to flight hardware and telemetry. The study cites both foundational wake vacuum theory (Melfi, Hueser, Naumann) and contemporary Monte-Carlo work, demonstrating engagement with prior literature.The 22-page analysis, including derived desorption energies (~0.8 eV) and geometric scattering factors, shows rigorous quantitative treatment, although some constants were fitted to match data and would benefit from independent verification. Overall, the combination of peer review, direct experimental access, and transparent error analysis render the source highly credible for technical design insights, while reminding readers to treat absolute pressure figures with caution
Connection
SpaceForgeOS aims to replicate WSF-type wake growth conditions for orbital semiconductor deposition. This paper offers actionable guidance on three fronts:

1. **Pressure Floor & Bake-Out** – The finding that incomplete degassing limited wake pressure to ~10^-9 Torr suggests we must schedule an extended on-orbit bake to reach the 10^-13 – 10^-14 Torr goal. Incorporating a pre-growth "outgassing timer" into the

scheduler, and logging true outgassing rate rather than net pressure will tighten simulation fidelity.

2. **Thermal-Desorption Dynamics** – The observed 1/4-orbit phase lag between ram and wake pressures, driven by solar heating, will be embedded in the ST-GNN training data so the AI scheduler anticipates diurnal spikes that could jeopardise layer purity. Temperature nodes for chassis, shield, and source cells already in our graph can directly ingest the 50–70 degrees celsius cyclic range reported here.

Beringer, Dennis B., et al. "Space Ultra-Vacuum Facility." NASA, Marshall Space Flight Center, Patent No. US5092545A, filed May 8, 1986.

Summary

This NASA patent (Case No. MFS-28139-1) lays out the conceptual design, deployment sequence, and operating method for a “Space Ultra-Vacuum Facility” created around a truncated, hollow hemispherical wake-shield. The shield’s convex face carries the material processing site at its apex and is oriented toward the orbital wake; all power, control, and attitude-keeping hardware rides on the concave face, which points into the ram flow. By removing walls from the line of sight of the growth surface and pushing out-gassing subsystems upwind, the geometry blocks both direct molecular out flux and back-scattered ram molecules, enabling vacuum levels that ground chambers struggle to reach (targeting =< 10^-12 Torr).

The patent describes a carousel that indexes multiple substrates under extendable fixtures: (1) a micro-gravity molecular-beam-epitaxy (MBE) gun; (2) an optical diagnostics head for in-situ monitoring. The deployment process includes: (i) grapple and release from the Shuttle bay, (ii) fly convex-face-forward to let ambient atomic oxygen scrub hydrocarbons, (iii) sun-pointing “bake-out” to drive off residual volatiles, and (iv) flip to the operational attitude (concave face forward, convex face in the wake) for growth runs. Next, the free flying platform is retrieved by the Shuttle arm. The inventors argue that the arrangement slashes contamination risk, shrinks on orbit cleaning costs by exploiting natural atomic oxygen and solar heating, and opens paths not only for MBE but also mirror coating, materials ultra-purification, and fundamental surface studies.

Credibility

This disclosure emanates directly from NASA’s Marshall Space Flight Center. The organization that ultimately built and flew the Wake Shield Facility (WSF). The document furnishes detailed schematics, materials choices (low-out-gassing stainless steel), and step by step flight operations, reflecting engineering grade rigor rather than speculative theory. Performance claims rest on analysis and sub-scale tests available at the time (1986 filing); key vacuum figures were only fully assessed in-flight years later. In sum, the source is authoritative for system architecture and operational logic, with the usual caveat that quantitative promises pre-date full-scale verification.

Connection

We can adopt the three-stage conditioning loop—atomic-oxygen scrub, solar bake-out, then flip—into our automated scheduler. Embedding those maneuvers into our attitude-control sequences should let us hit the out gassing thresholds demanded by our simulation (=< 3 × 10^7 molecules cm^-2 s^-1) without adding massive heater mass.

Sahili, Z. A., & Awad, M. (2023, February 11). *Spatio-temporal graph neural networks: A survey*. arXiv.org. https://arxiv.org/abs/2301.10569

Summary

In this survey we get a map of the entire ST-GNN landscape: a two-way taxonomy; **hybrid** models that bolt a temporal block (1-D CNN, RNN, Transformer) onto a spatial GNN, and GNN-only models that fold time directly into the graph (as edges, signals, sub-graphs, or filters). The authors catalogue 25+ architectures, lay out a matrix of their spatial/temporal choices, and show how those design decisions line up with seven application buckets, from traffic and PV-power forecasting to sign-language translation. A final section flags six open pain-points: benchmark scarcity, data augmentation, federated privacy, etc.

Credibility

The piece compiles 100+ primary papers, cites canonical GNN work (GCN, GAT, GIN, Graph Transformer), and gives useful side by side algorithm tables. Although peer review is pending, both authors sit at research universities with prior GNN publications.

Connection

We can lift two direct benefits from this paper. The first being design short-listing; the survey's hybrid vs. GNN only split helps us justify why our scheduler prototype uses a diffusion-based hybrid layer (spatial GCN + temporal Transformer) rather than trying to encode time as edges. Secondly Gap spotting; the open challenge list highlights federated learning and AutoML for ST-GNNs, exactly the niches where our SpaceForgeOS deposition module roadmap aims to innovate. Citing this survey in the bibliography shows we are building on the state of the art while carving out a clear research delta.

Cuéllar Carrillo, Sara, et al. "Explainable Anomaly Detection in Spacecraft Telemetry." *Engineering Applications of Artificial Intelligence*, vol. 133, 2024, article 108083.

Summary

This paper proposes a hybrid anomaly detection system that combines recurrent neural networks (RNNs) with SHAP (SHapley Additive explanations) to diagnose irregularities in spacecraft telemetry. The authors focus on time-series sensor data and show how SHAP can identify which input signals most influence anomaly classifications. Their model is trained and validated on satellite telemetry datasets, producing not only alerts but also human readable explanations for each flagged event.

Credibility

Published in a high impact journal and backed by a consortium of European aerospace researchers, the study reflects cutting-edge applications of XAI in mission-critical settings. The authors demonstrate both strong experimental design and domain familiarity, using real world datasets from ESA and adhering to stringent validation protocols.

Connection

In our system, real-time sensor feeds from deposition chambers (e.g., pressure, flow, power draw) may spike during orbital operations. Integrating a similar XAI-based anomaly detection pipeline would let us trace anomalies not only to values but to their likely causes. Thus enhancing the overall safety, preventing component damage, and supporting autonomous corrections. This approach strengthens our reliability goals in low-maintenance environments like LEO foundries.