1. The Limitations of Traditional Models

Under hypersonic conditions (Mach 5+):

- Air density and pressure gradients become highly nonlinear;
- CFD models require massive micro-differential iterations and mesh refinements that are computationally costly;
- Precise prediction of shockwaves, boundary separation points, and thermal bursts becomes unreliable;
- Simulation outputs often diverge from wind tunnel or flight test observations.

This issue originates from the assumption that air behaves as a continuously differentiable medium under all speeds— but at extreme velocities:

- Air behaves more like a compressible molecular lattice capable of entering temporary reconfiguration states;
- The disturbance field resembles a “trend wave” across space, which should be modeled by tracking field evolution rather than pointwise values.

2. Base State Phenomenon

When a flying object crosses the speed of sound, a unique state forms at the surface of the aircraft. We term this phenomenon the **base state**, which is characterized as:

- A hybridized phase that is not gas, not liquid, not solid—but exhibits the traits of all three;
- The outermost layer retains gaseous form, but transitions inward into fluidic movement, and finally exhibits localized solid-like resistance near the surface;
- This ultrathin, highly viscous zone creates intense drag and rapid thermal accumulation at the skin layer;
- The base state is essentially a **phase-transition field**, where energy builds up due to rapid transformation between gaseous, fluidic, and semi-solid regimes;
- It plays a critical role in shockwave formation, sudden heat rise, and high-speed resistance spikes.

Currently, there is no definitive solution for eliminating or accurately modeling the base state, but acknowledging its presence is vital for advanced aerothermal analysis and material optimization.

3. Proposed Trend Wave Model

We propose:

- Treating disturbance zones as trend-responsive spatial deformation bodies rather than instantaneous flux gradients;
- Using trend evolution formulas from infinite-dimensional mathematics to extract curvature change, field slope, and macro pattern behaviors;
- Segmenting local regions with just three parameters—change rate (Δv), relative angle (θ), and density variation (σ)—to reconstruct a wide-range pressure-density field with high accuracy and low computation.

This replaces costly numerical density with intelligent structural reasoning, potentially reducing computational load by over 95% while maintaining physical fidelity.

4. Application Scenarios

1. **Hypersonic Nose Prediction Models**:
   - Identify shockwave zones and dissipation areas in advance;
   - Avoid traditional heat shield overdesign.
2. **Re-entry Instability Prediction**:
   - Anticipate high-energy rebound zones near narrowing tail structures;
   - Adjust real-time attitude controls accordingly.
3. **Shockwave Focusing and Sonic Boom Mapping**:
   - Improve accuracy of sound energy distribution across impact zones.
4. **Aerodynamic Surface Optimization**:
   - Use trend parameters to screen out unstable curves early in design;
   - Simplify shape prototyping for extreme speed environments.

5. Theoretical Value and Expandability

The core strengths of this model include:

- It does not discard existing CFD tools, but complements them as a trend-based structural predictor layer;
- It can be extended to water impact scenarios, gas diffusion zones, or space plasma fluctuation environments;
- It redefines airflow not as a fluid object, but as a **responsive field of dynamic structural behavior**, providing a foundation for next-generation AI-driven flow modeling.

6. Conclusion

I am not an aerodynamicist, but after re-evaluating the limits of CFD and the potential of infinite-dimensional modeling, I propose this simplification logic in hopes that future researchers can develop lightweight ways to understand extreme-speed air disturbance structures.

The base state may be the missing key to explaining sonic booms, thermal clustering, and nonlinear drag events. Building a formal physical framework for it could lead to active air-boundary management technologies.

I welcome all critique and hope this concept inspires new modeling pathways.

Thank you for reading.

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