CBD Disk Code Development: Current Status and Next Steps

1. Where We Stand (Stage Summary)

Stage 1–2 (Numerical Infrastructure) – Completed:
- 1D viscous diffusion (theta-scheme)
- Consistent inner/outer boundary conditions
- Unified mdot definition via compute_LSigma
- Inward-positive mass flux convention

Stage 3 (Thermal Structure) – Completed:
- Local energy equation (ODE / PDE forms)
- Fully implicit solver with reject-on-failure safeguard
- Correct OP / AESOPUS / Semenov branch selection
- Strict clamp (no extrapolation) opacity policy
- dlogT smoothing for physical stability
- Validation tests (no irradiation, constant kappa_es)

Stage 4 (Irradiation + Shadow + Diagnostics) – Completed:
- LOH24 Eq.(16) irradiation implementation
- Shadow on/off capability
- Self-consistent delay_sec = 0 approximation
- Hot region diagnostics:
* Inner-connected hot zone
* Detached islands
* Edge-interpolated r_hot_outer
- Parameter sensitivity tests (dt, dlogT, irradiation)
- Identification of intrinsic thermal instability

2. Recommended Next Focus (Stage 5)

Priority: Physical Interpretation and Classification

5A. Clarify Thermal Instability Mechanism:
- Identify trigger conditions
- Characterize growth/decay timescales
- Separate intrinsic instability from irradiation amplification

5B. Construct Phase Diagram:
- Stability vs. oscillation vs. runaway
- Parameter space: alpha, dlogT, irradiation, shadow
- Identify physically meaningful regimes

This stage transforms numerical results into publishable physics.

3. Immediate Action Items

1. Correlate r_hot_outer with mdot_inner.
2. Compare irradiation ON/OFF time series under identical initial conditions.
3. Quantify shadow impact on oscillation amplitude.
4. Investigate dt sensitivity as potential sign of excitable or chaotic behavior.

These steps will solidify the physical interpretation.