Theoretical expectations for quiescent CV colors

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CV Light Components

Old: \( \dot{j}_{\text{binary}} = \text{Gravitational Wave emission} \)

Quiescent Light:
- WD thermal
- Red companion

Companion: Roche Lobe filling

Companion Evolution

Binary Evolution
**WD Thermal Component**

Observed timescales in DN:
- Disk Outburst: days-month
- Between Outbursts: month-years

No accretion light in quiescent state, only WD thermal emission.

Ideally would like to predict

\[ T_{\text{eff}}(M, \langle \dot{M} \rangle) \]

which would tie the WD evolution to that of the binary.

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**Accreting WD Envelope**

Envelope thermal time

\[ \sim 10^3 \, \text{yr} \]

quasi-static envelope; local derivatives give

\[ L_{\text{env}} \sim g h \langle \dot{M} \rangle \]
\[ \sim \langle \dot{M} \rangle \frac{k T_c}{\mu m_p} \]

So actually:

\[ T_{\text{eff}}(M, \langle \dot{M} \rangle, M_{\text{acc}}, T_c) \]
Core will be Reheated until equilibrium is reached.
Core thermal time $\sim 10^8$ yr

Thus we obtain $T_{\text{eff}}(M, \langle \dot{M} \rangle)$
$\rightarrow$ WD $T_{\text{eff}}$ tied to binary evolution.
Cooling-Heating Cycle

- Core will be Reheated until equilibrium is reached.
  - Core thermal time $\sim 10^8$ yr
  - Thus we obtain $T_{\text{eff}}(M, \langle M \rangle)$
  - $\rightarrow$ WD $T_{\text{eff}}$ tied to binary evolution.

Predicted $T_{\text{eff}}$

- Relates broadband fluxes for quiescent or hibernating CV systems to binary evolution.
$T_{\text{eff}}$ Evolution

$\dot{M} = 0.6 M_\odot$ from grav. waves


Transition from main sequence broadband fluxes to those of a WD.

WD Mag from (Bergeron, Wesemael, & Beauchamp 1995, PASP, 107, 1047)

Old CV evolution on CMD

M4 Predicted CV Color Evolution

0.6 M_\odot accretion disk included

Proper-motion selected members of M4 at 4 core radii

Old CV evolution on CMD

Conclusions:
We predict quiescent CV WD $T_{\text{eff}}(M, \langle M \rangle)$, allowing for additional observational constraints on the binary.
Reheated CV primaries intertwined with younger, isolated WDs.
Modern deep observations of GCs offer opportunity to study old CV population.