Massive star winds interacting with magnetic fields on various scales

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Collaborators

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Massive star winds

Grosdidier et al., 1998
Massive star winds

Credit: S. Owocki
Massive star winds

Formation of a P-Cygni Line-Profile

Credit: S. Owocki
Massive star winds

Credit: R. Prinja
Massive star winds

\[
\log \dot{M} = -6.697 \pm 0.061 \\
+ 2.194 \pm 0.021 \log \left( \frac{L_*}{10^5} \right) \\
- 1.313 \pm 0.046 \log \left( \frac{M_*}{30} \right) \\
- 1.226 \pm 0.037 \log \left( \frac{v_\infty}{v_{\text{esc}}} \right) \\
+ 0.933 \pm 0.064 \log \left( \frac{T_{\text{eff}}}{40000} \right) \\
- 10.92 \pm 0.90 \left\{ \log \left( \frac{T_{\text{eff}}}{40000} \right) \right\}^2 \\
+ 0.85 \pm 0.10 \log \left( \frac{Z}{Z_\odot} \right)
\]

for \( 27500 < T_{\text{eff}} \leq 50000 \) K

Vink et al., 2001
Massive star magnetism

• Surface magnetic fields found in about 7% of OB stars (e.g., Wade et al. 2014, Morel et al. 2015)

• Most detected fields are well-organized, global dipolar fields

• They are stable over large periods of time
Massive star magnetospheres

Nazé, 2017
Massive star magnetospheres

Owocki et al., 2016
Massive star magnetospheres

Petit et al., 2013
Massive star magnetospheres

ud-Doula et al., 2008
Mass loss quenching

\[ f_B = \frac{\dot{M}}{\dot{M}_{B=0}} = 1 - \sqrt{1 - \frac{R_*}{R_c}}. \]

Petit et al., 2017
Massive star magnetospheres

Townsend et al., 2005
Massive star magnetospheres

Owocki et al., 2016
ADM predictions

Nazé et al., 2014
ADM predictions

Owocki et al., 2016
ADM predictions

Wade et al., 2011
ADM predictions

→ See talks by J. Krtička and M. Muñoz

Wade et al., 2011
Magnetospheric viewing angle

Rauw et al., 2000
NGC 1624-2

Wade et al., 2012
NGC 1624-2

David-Uraz et al., in prep
Comparison to other magnetic O stars

David-Uraz et al., in prep
Deriving mass-loss rates from UV lines

Marcolino et al., 2013
UV radiative transfer from MHD simulations

Marcolino et al., 2013
Preliminary UV radiative transfer from ADM

Erba et al., 2017
Complex fields

Donati et al., 1996
Complex fields

Donati et al., 1996
Complex fields

→ See talk by C. Fletcher

Donati et al., 1996
Smaller scale fields?

Kaper et al., 1997
Co-rotating surface spots

Cranmer & Owocki (1996)
Magnetic spots?

\[ T(\tau' = 2/3) = T_{\text{eff}} \left(1 + \frac{3\kappa B^2}{32\pi g}\right)^{\frac{1}{4}} \]

David-Uraz et al. (2014)
Spot detection in MOST data

Ramiaramanantsoa et al. (2014)
Synthetic discrete absorption components

David-Uraz et al. (2017)
New theoretical boundaries

Ramiaramanantsoa et al. (subm.)
Conclusions and future work

• Magnetic fields have a determining effect on the velocity and density structure of hot star winds

• Spherically symmetric models cannot lead to proper wind property determinations for magnetic massive stars

• Heretofore undetected small scale magnetic fields could possibly explain phenomena in OB stars
Thanks for your attention!