Reviving the Single Degenerate Scenario for the Ia Supernova Event that Formed Remnant 0509-67.5

Image Credit-Hubble Heritage

Luke Hovey: 6 June, 2016

Los Alamos National Laboratory

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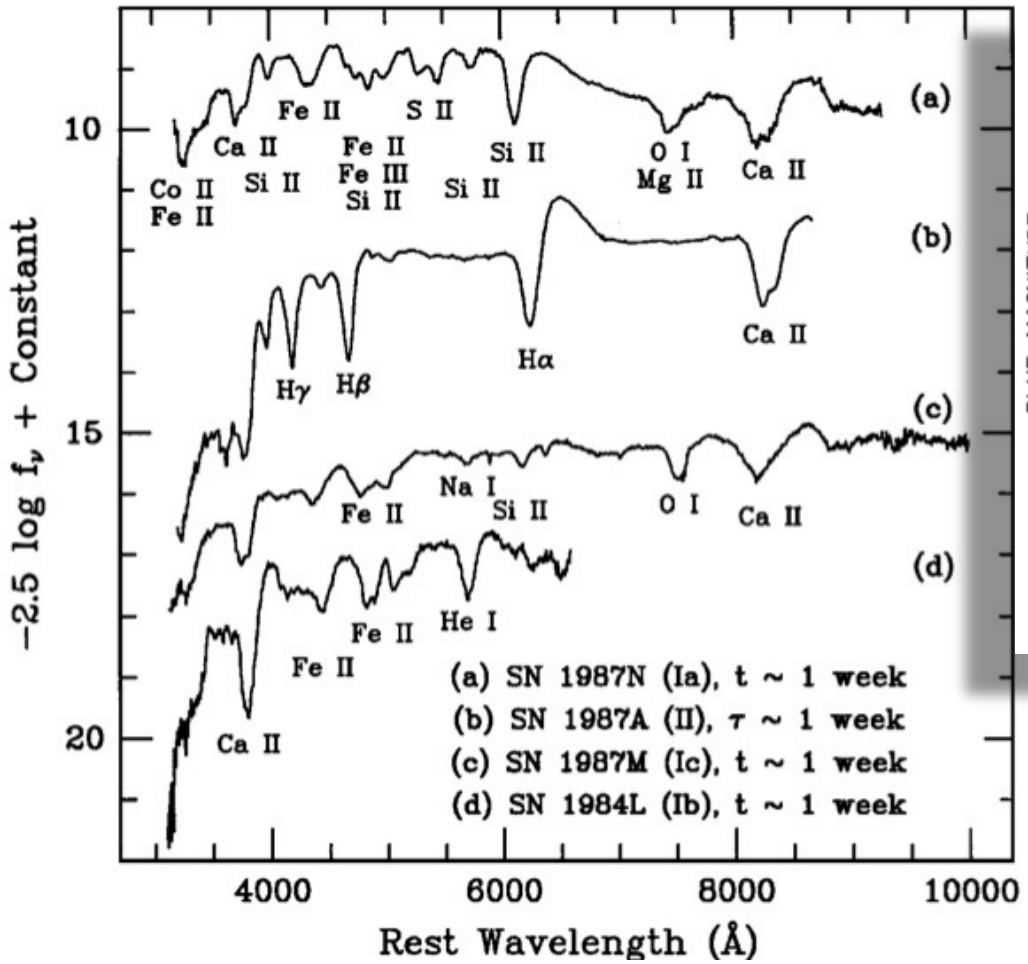
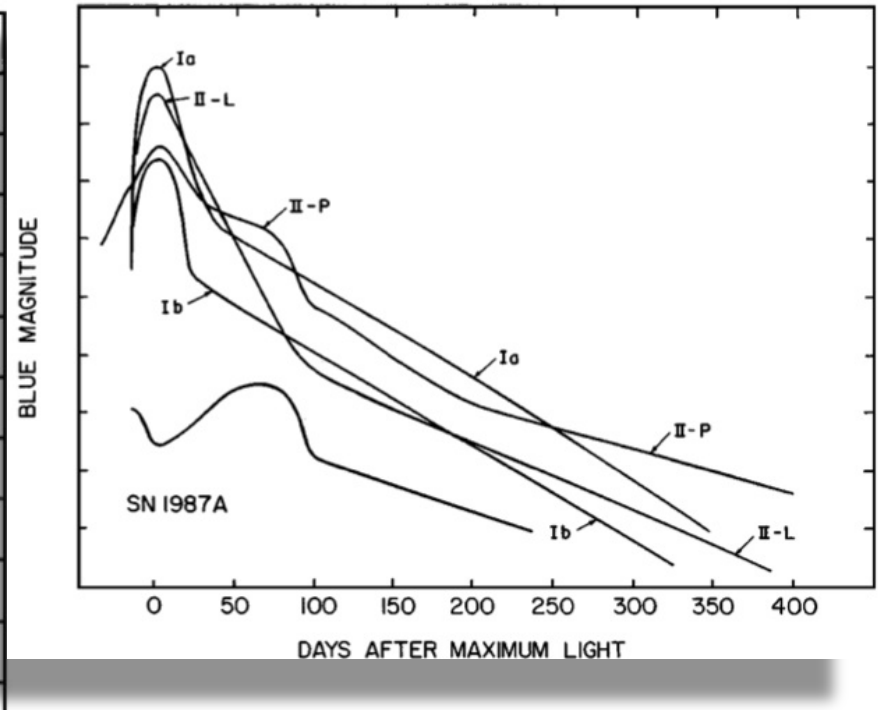
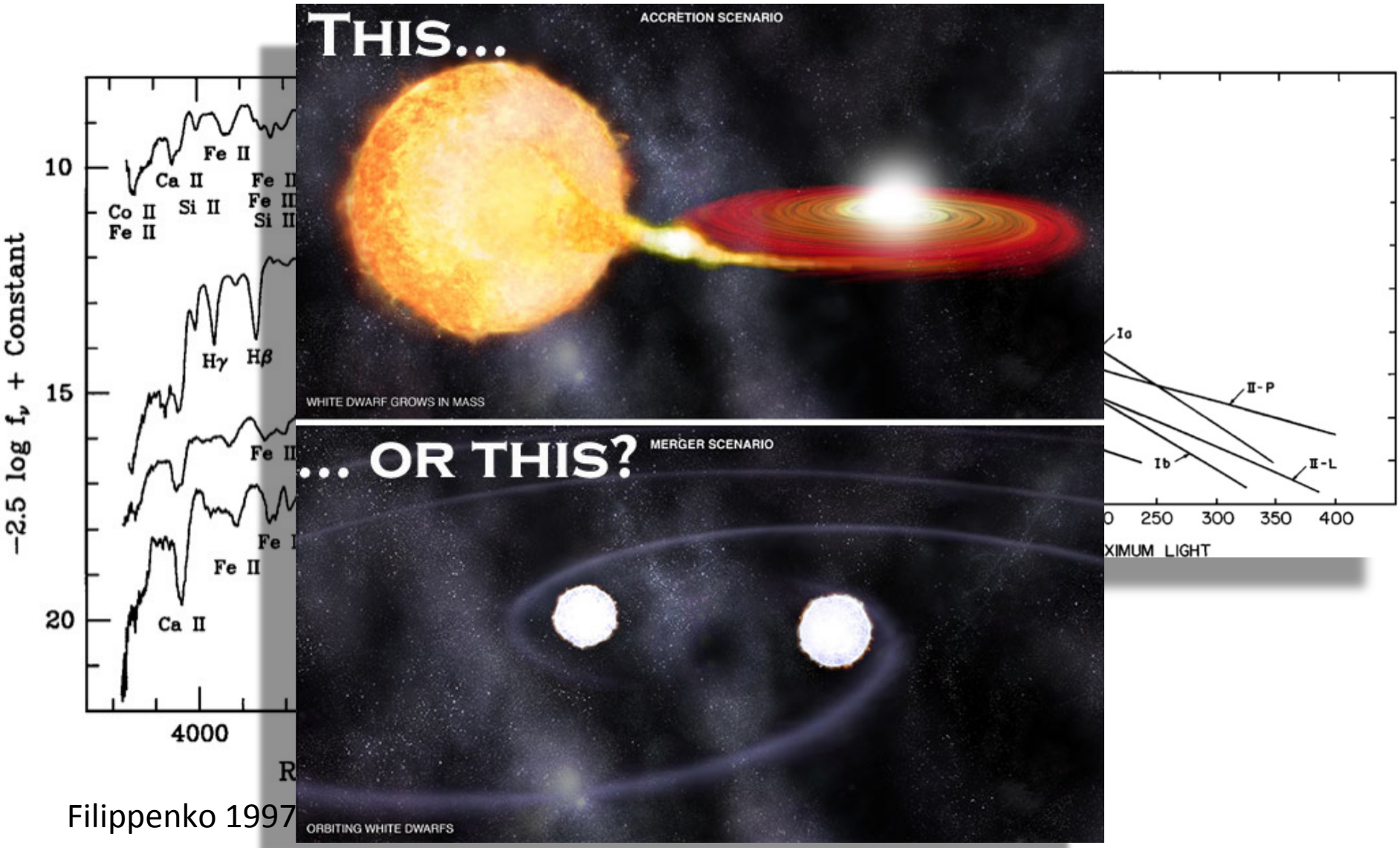
Ia Supernovae





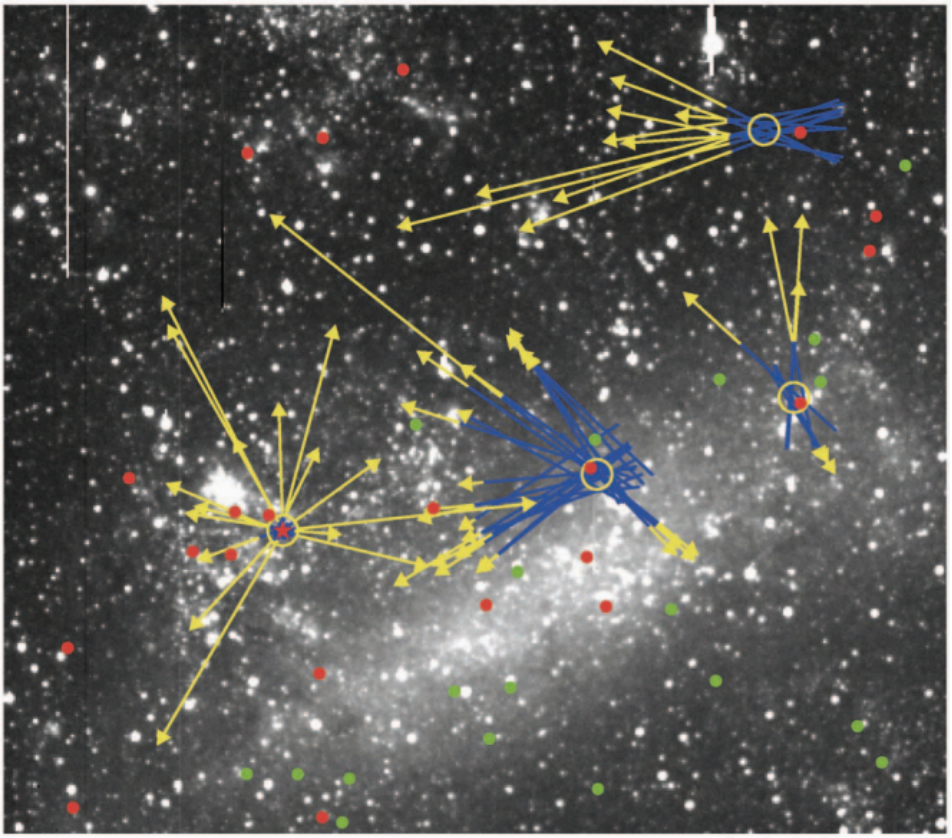
Filippenko 1997

Ia Supernovae

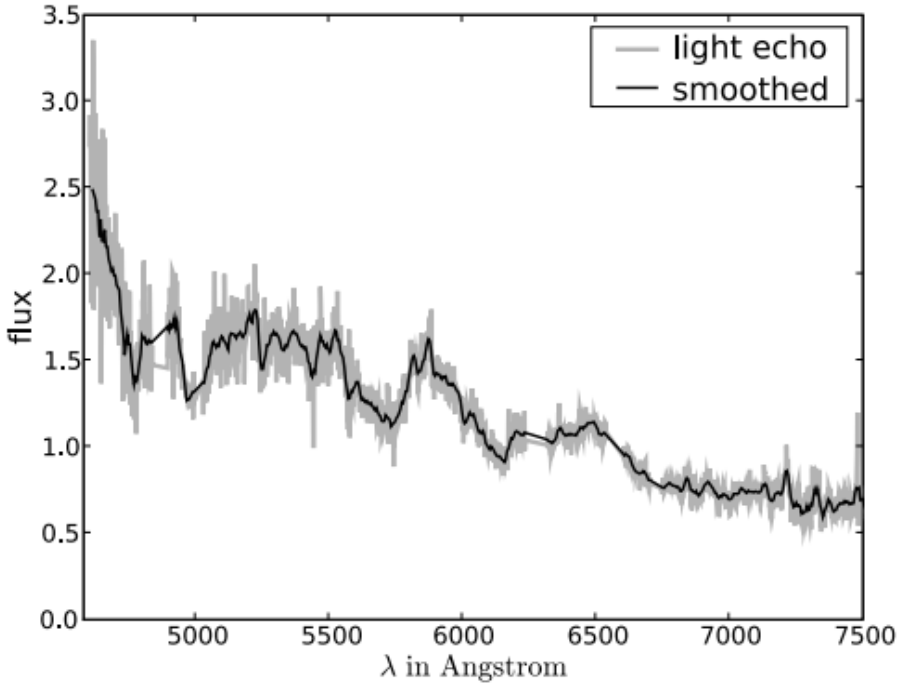


Filippenko 1997

Ia Identification of 0509-67.5

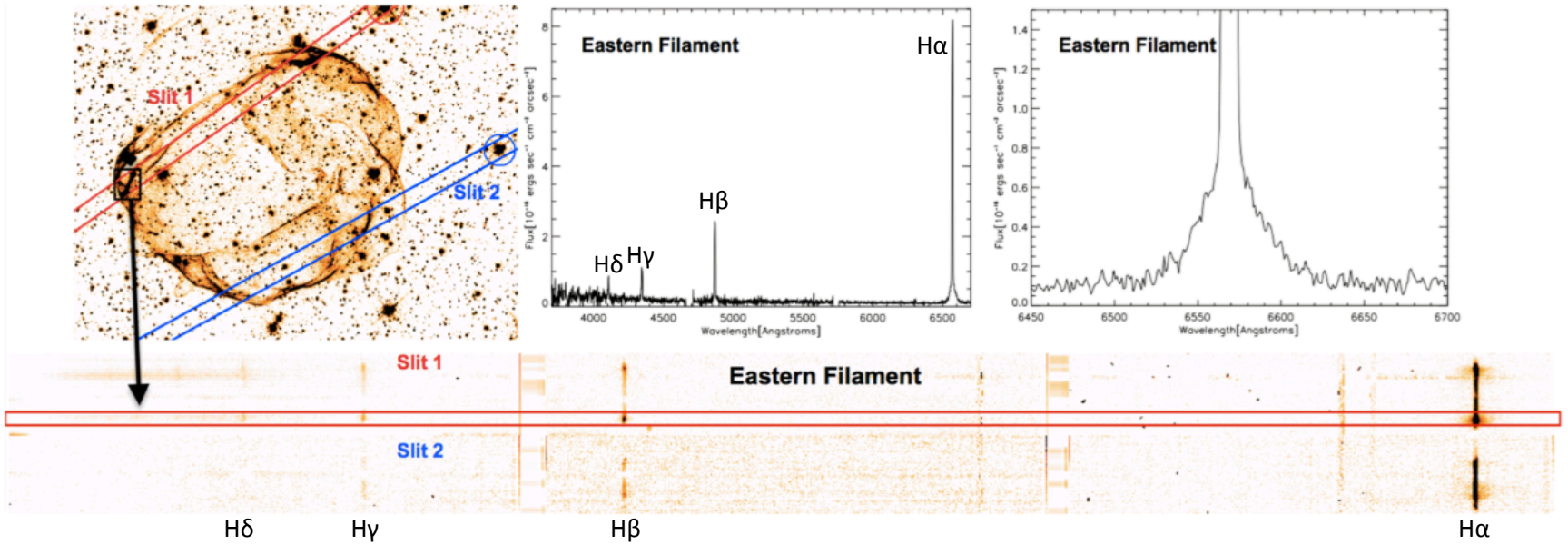


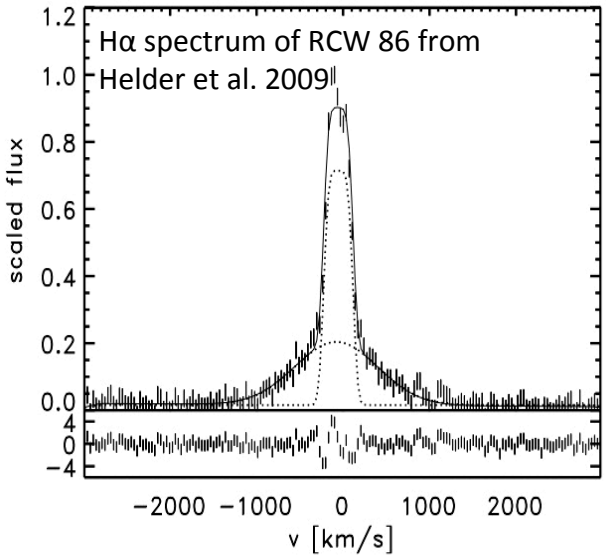
Rest et al. 2005



Rest et al. 2008

Balmer-dominated Shocks





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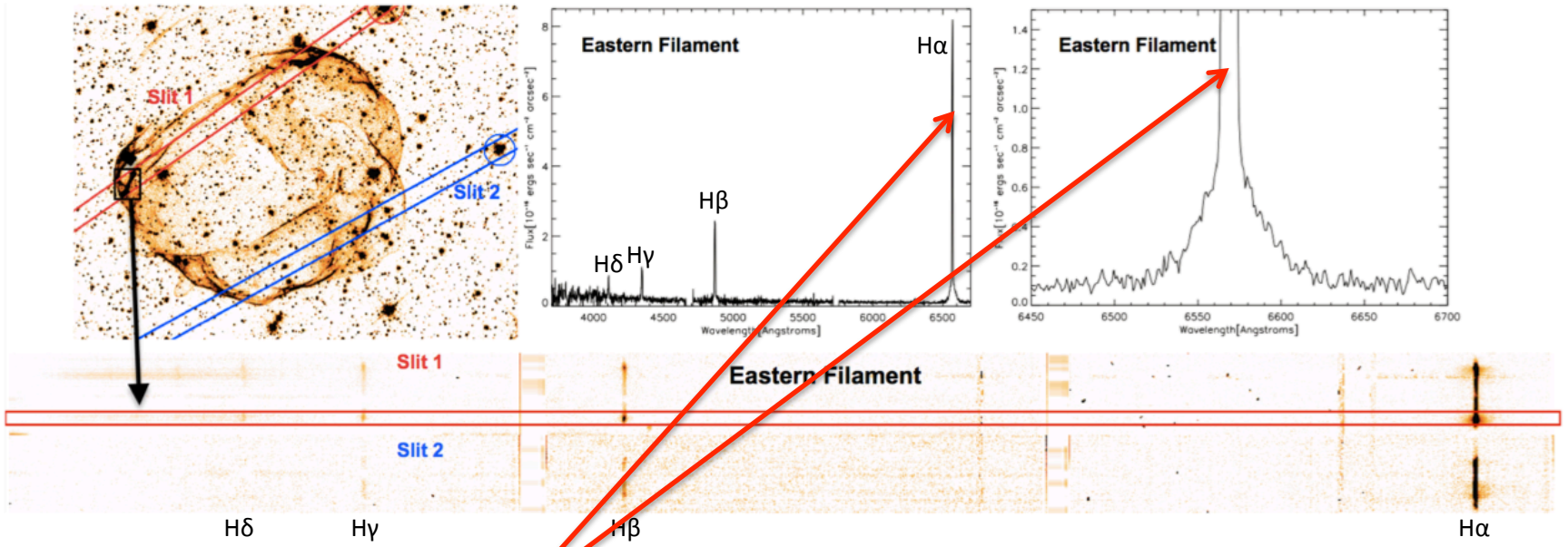
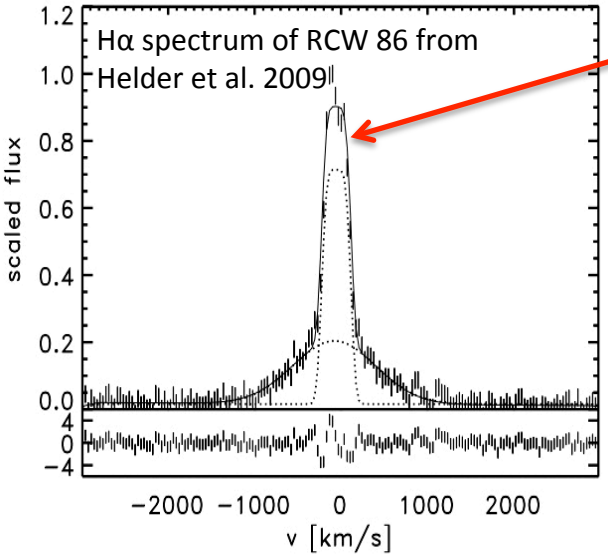
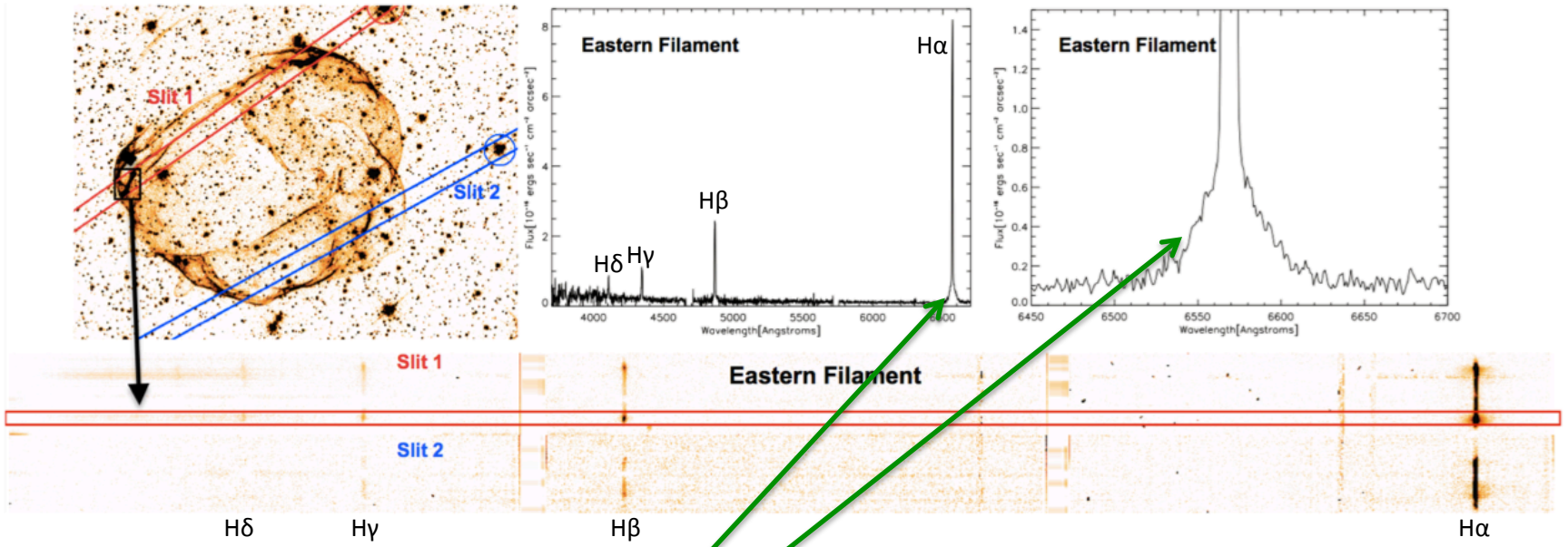
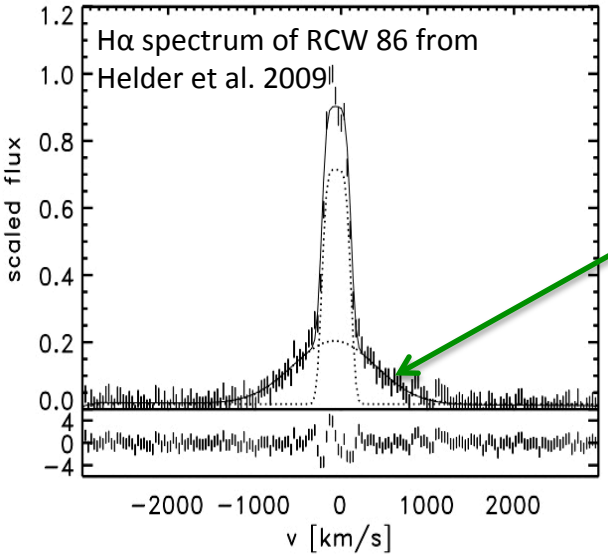




Narrow Hα – collisional excitations of hydrogen entering the forward shock

Balmer-dominated Shocks

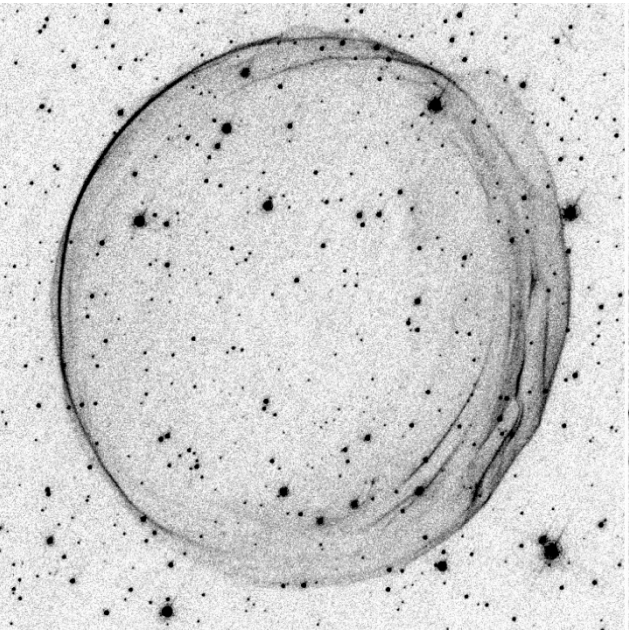
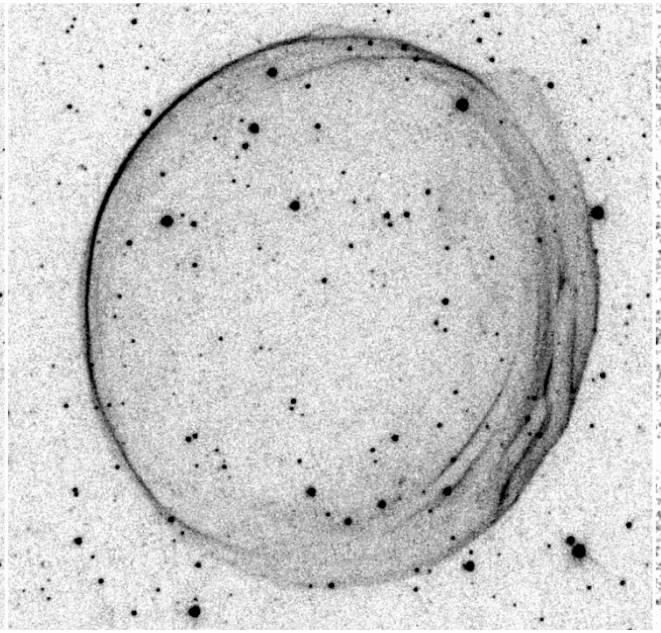
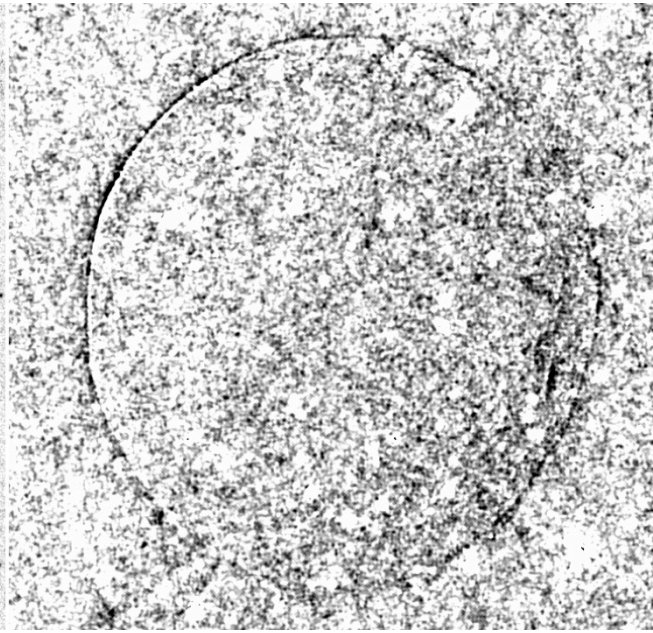




- Narrow Hα – collisional excitations of hydrogen entering the forward shock
- Broad Hα – Charge transfer from neutral hydrogen entering the forward shock that exchange their electron with a post-shock proton

Measuring Global Shock Speed

Results from Hovey, Hughes, and Eriksen 2015

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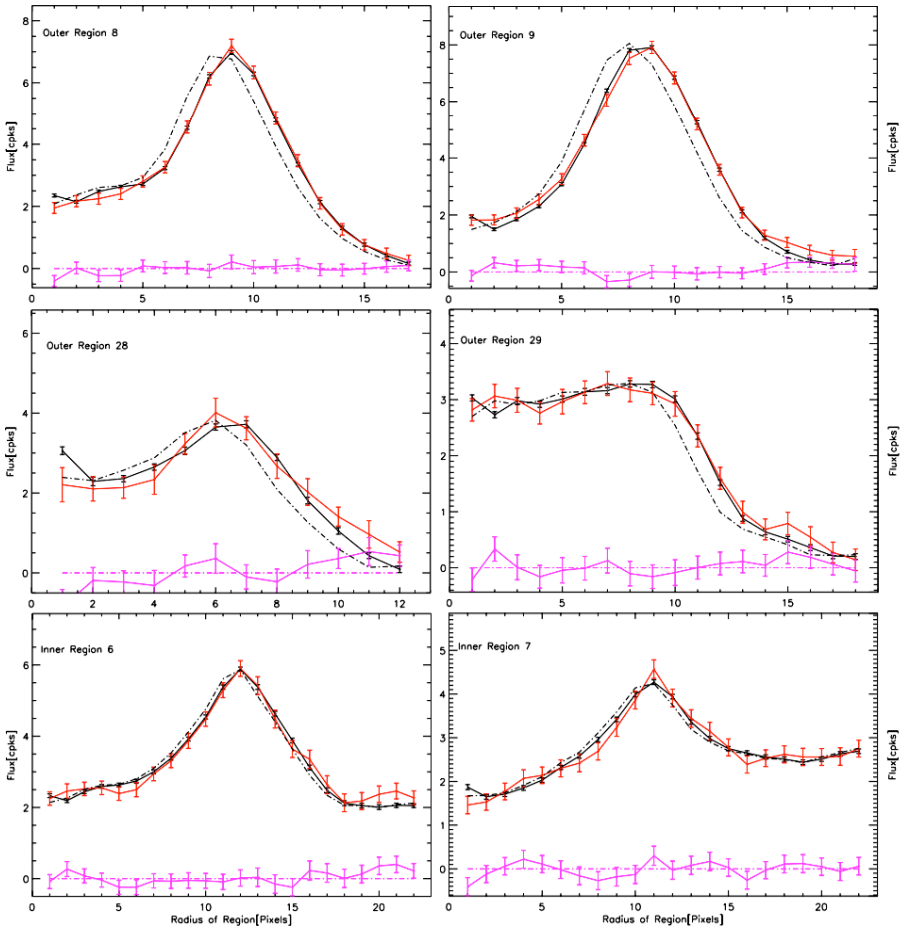

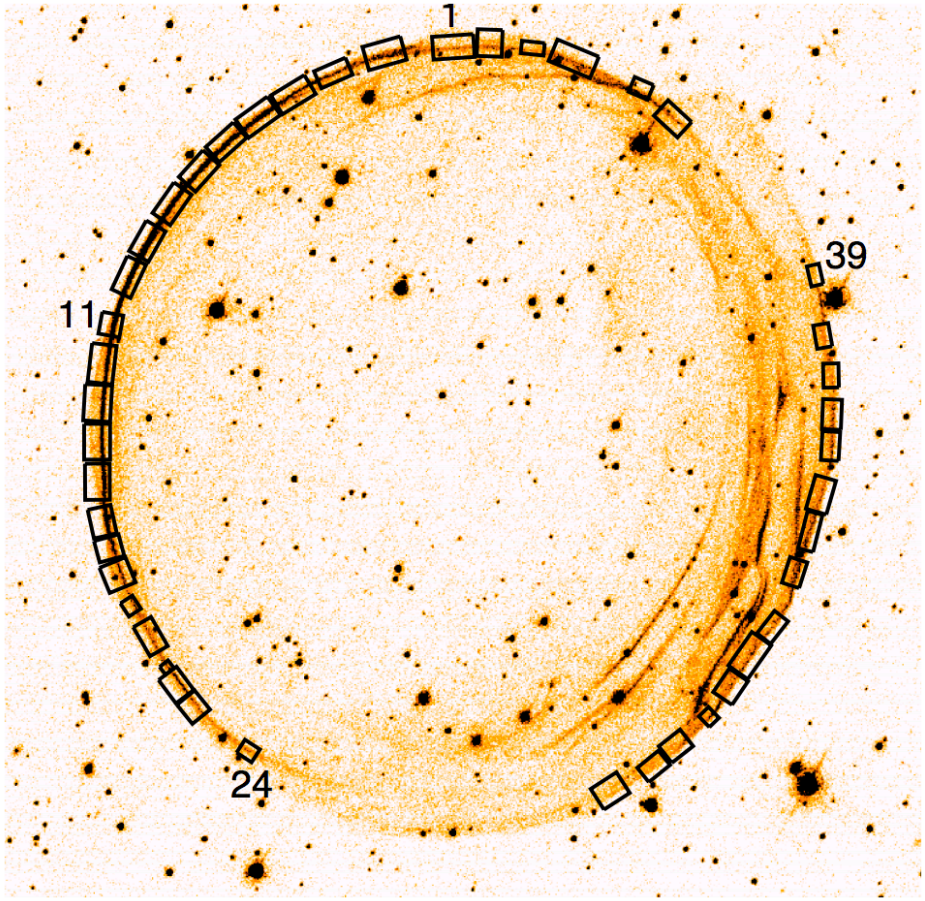

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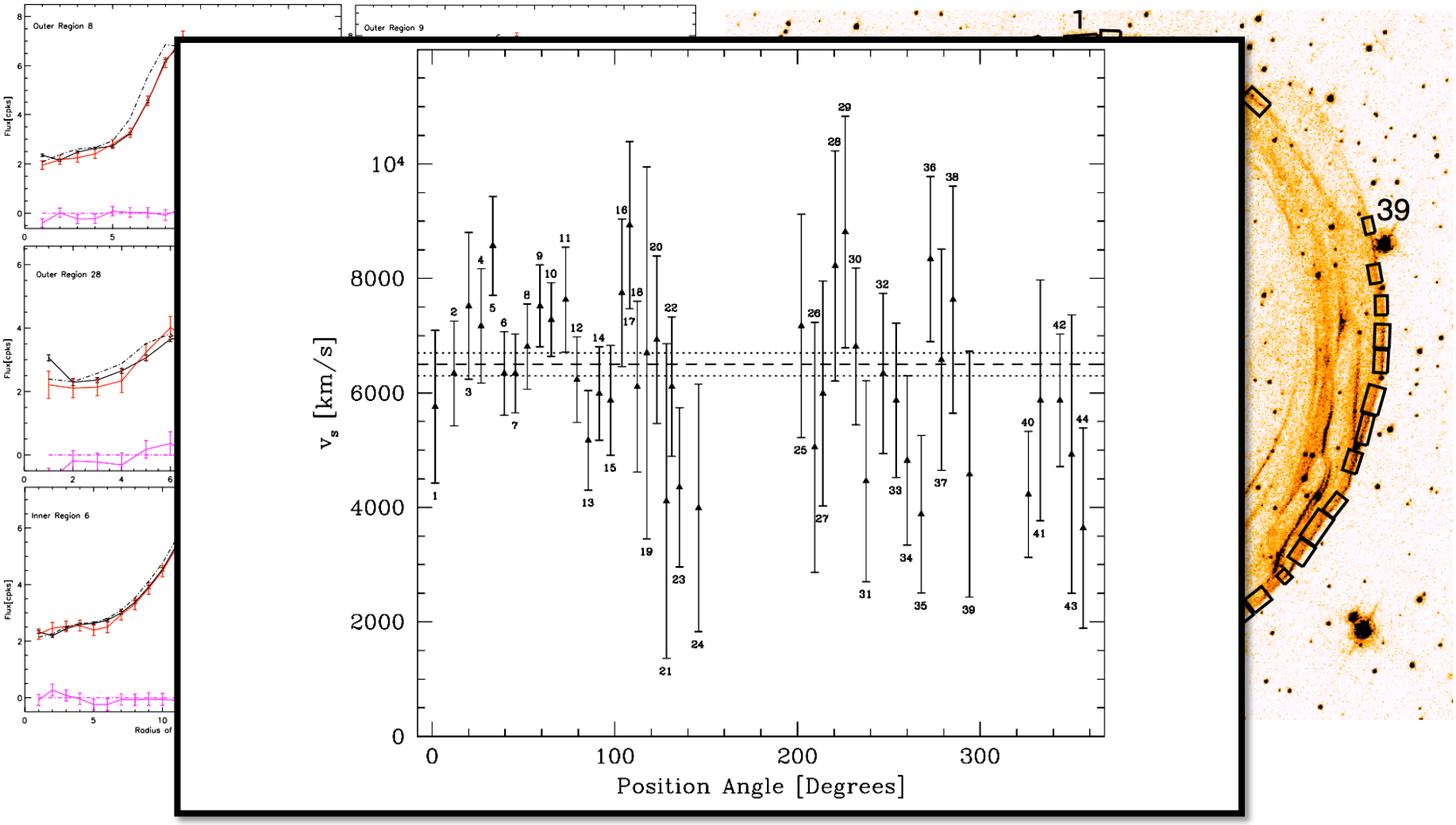
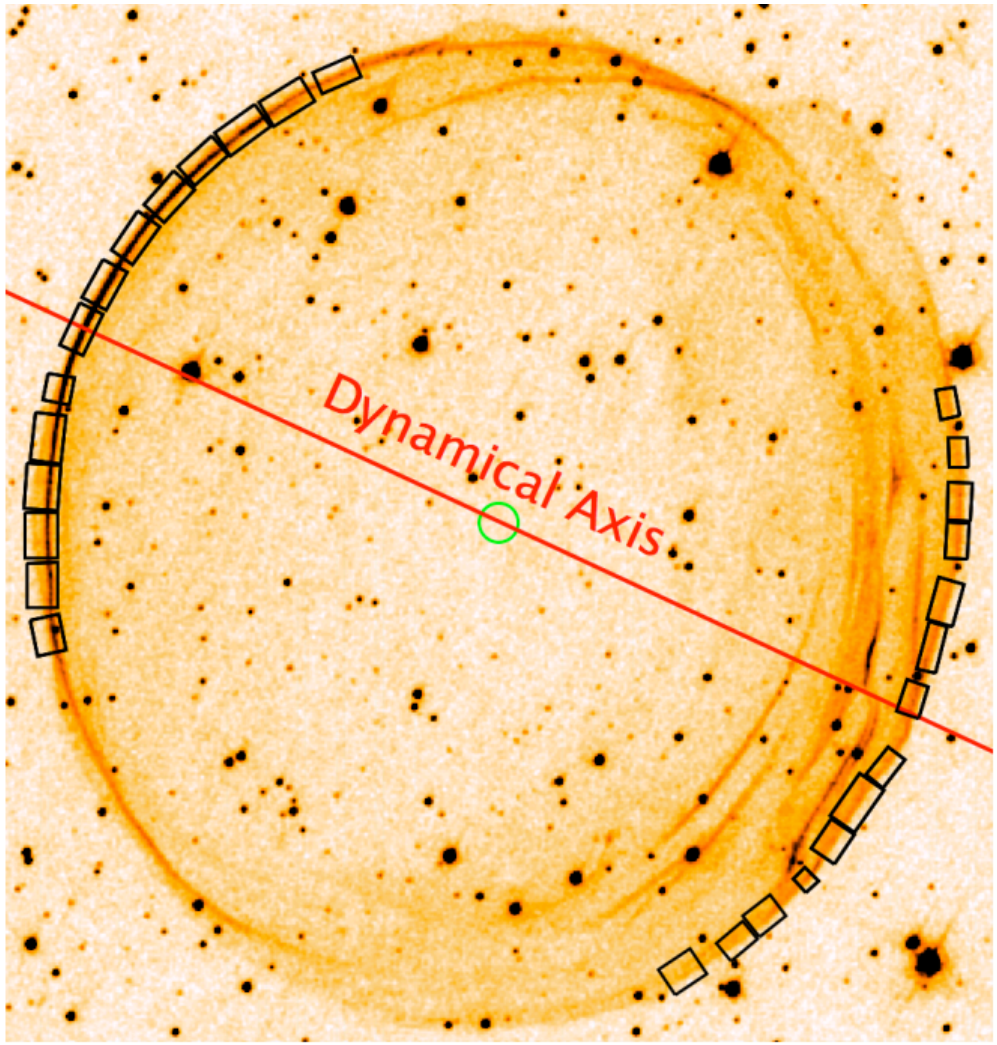


Searching for a Dynamical Offset



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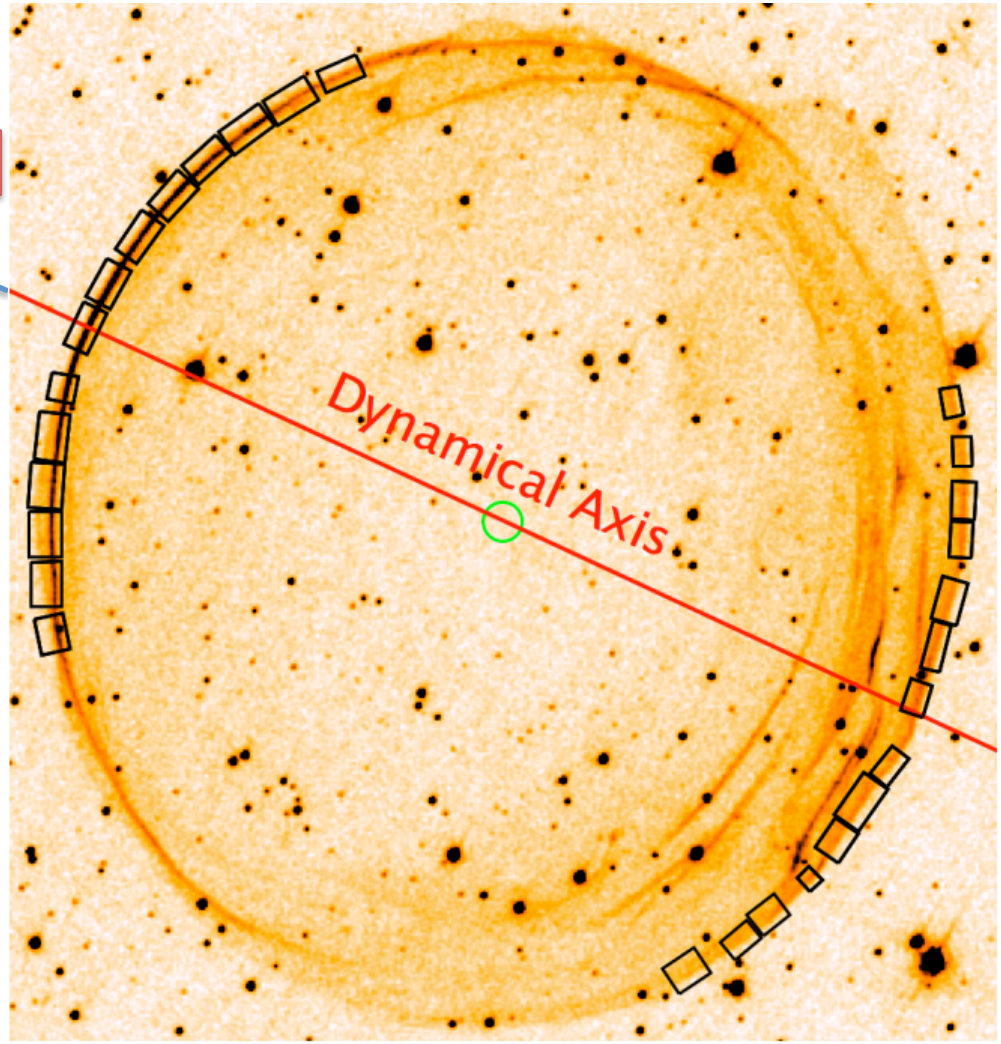


$V_{east,\ proj.}$ = 6730±160 km s^{-1}

$R_{east,\ proj.}$ = 13.230±0.025''

$V_{west,\ proj.}$ = 5740±380 km s^{-1}

$R_{west,\ proj.}$ = 13.120±0.023''

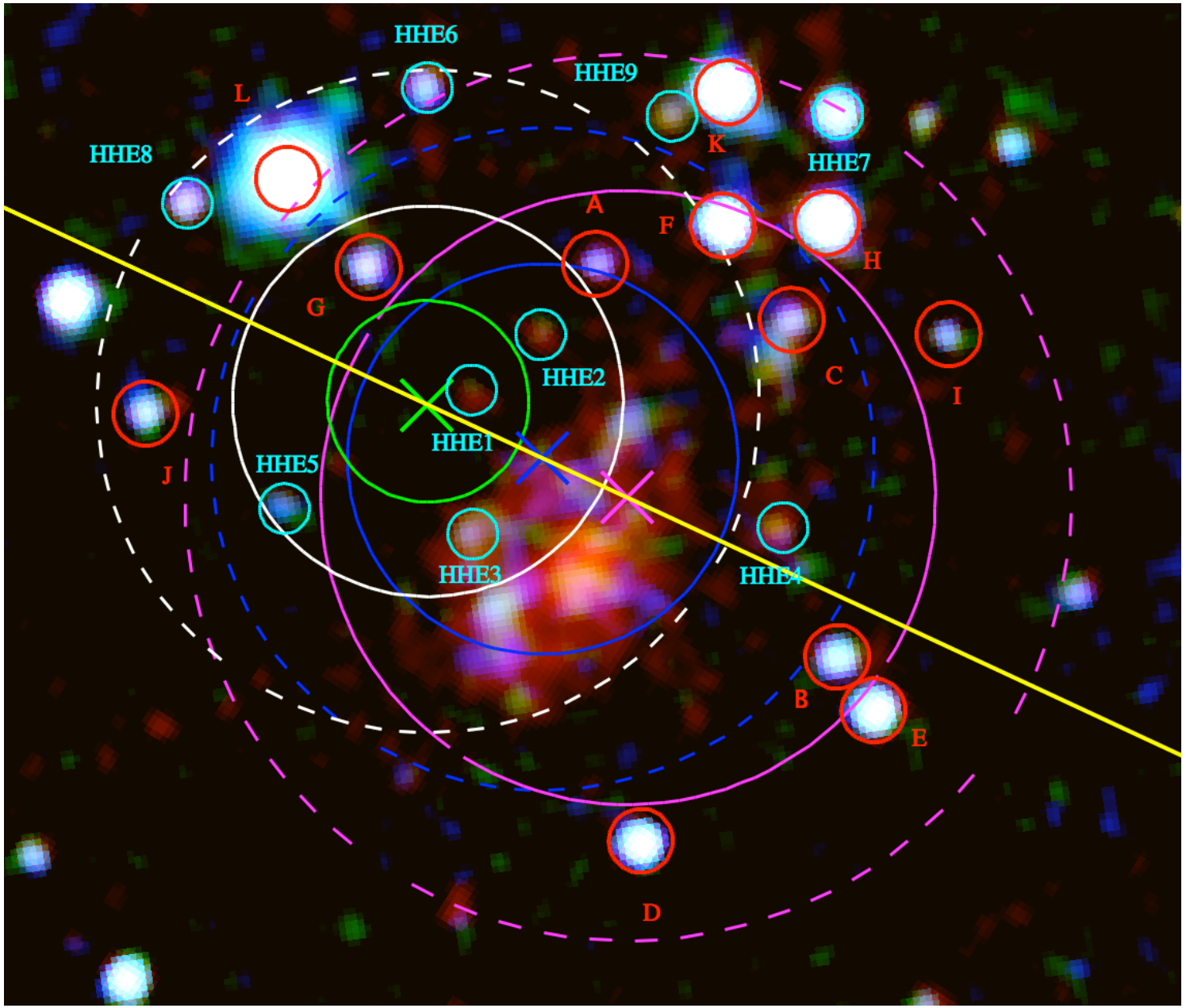
Projecting velocities and radii along our dynamical axis

Single Degenerate Model Redux

Varying Parameter	E_{51}, $M_{ej}/M_\odot$	ρ_{west}/ρ_{east}	$\log_{10}(\rho_{west}{}^{(1)})$	$\log_{10}(\rho_{east}{}^{(1)})$	Shift	t_{min} [years]
$\rho_{west,\ east}$	1.0, 1.4	2.42	-24.32	-24.70	$0.790 \pm 0.350''$	294
	1.2, 1.4	2.31	-24.19	-24.57	$0.790 \pm 0.350''$	288
	1.4, 1.4	2.31	-24.10	-24.46	$0.790 \pm 0.350''$	281
Varying Parameter	$M_{ej}/M_\odot$, $\rho_0^{(1)}$	E_{west}/E_{east}	$E_{west}{}^{(2)}$	$E_{east}{}^{(2)}$	Shift	t_{min} [years]
$E_{west,\ east}$	1.4, 3.6	0.49	0.76	1.54	$1.350 \pm 0.600''$	290
	1.4, 4.7	0.49	0.91	1.87	$1.370 \pm 0.603''$	283
	1.4, 6.0	0.48	1.06	2.20	$1.380 \pm 0.606''$	278

Note. — The west and east subscripts refer to east or west along our dynamical axis. (1) - *Density in units of* 10^{-25} *g cm*$^{-3}$. (2) - *Energy in units of* 10^{51} *ergs.*

Single Degenerate Model Redux



Possible Progenitor Companions

PHOTOMETRY OF PROGENITOR COMPANION CANDIDATES

Star	F475W	F555W	F814W	F110W	F160W
A	27.250±0.246	27.360±0.368	24.920±0.093	23.940±0.112	23.140±0.086
B	25.430±0.053	25.190±0.058	23.900±0.038	23.160±0.056	22.710±0.056
C	26.610±0.135	26.370±0.150	24.630±0.069	23.430±0.072	22.850±0.065
D	24.670±0.031	24.410±0.033	23.430±0.026	22.820±0.044	22.400±0.046
E	24.540±0.029	24.360±0.032	23.470±0.027	22.810±0.042	22.380±0.043
F	23.930±0.020	23.650±0.021	22.850±0.016	22.280±0.029	21.870±0.031
G	26.200±0.098	25.890±0.100	24.260±0.052	23.590±0.086	22.790±0.066
H	23.420±0.015	23.230±0.016	22.400±0.012	21.820±0.021	21.450±0.023
I	27.720±0.370	27.070±0.282	25.270±0.116	24.460±0.177	23.830±0.148
J	26.360±0.108	26.070±0.114	24.810±0.074	23.790±0.099	23.120±0.086
K	23.120±0.012	22.910±0.014	22.220±0.011	21.660±0.019	21.390±0.023
L	21.030±0.004	20.920±0.005	20.510±0.004	20.180±0.009	20.030±0.014
HHE 1	≥27.970[1]	≥27.590[1]	26.200±0.284	24.650±0.209	20.120±0.014
HHE 2	≥27.920[1]	27.870±0.572	25.970±0.236	24.470±0.180	23.950±0.174
HHE 3	27.200±0.216	26.410±0.150	24.450±0.056	22.140±0.025	22.080±0.035
HHE 4	27.980±0.452	27.380±0.361	25.120±0.107	23.710±0.089	23.140±0.079
HHE 5	27.340±0.255	26.620±0.184	26.900±0.551	24.580±0.196	23.280±0.097
HHE 6	26.490±0.124	26.460±0.163	24.660±0.066	23.720±0.098	23.170±0.098
HHE 7	24.710±0.032	24.510±0.035	23.480±0.025	22.900±0.047	22.300±0.042
HHE 8	26.280±0.099	25.960±0.102	24.540±0.056	23.480±0.080	22.840±0.072
HHE 9	27.750±0.375	26.510±0.170	25.120±0.101	21.660±0.019	21.390±0.023

NOTE. — All magnitudes reported with reference to Vega in each filter. These have *not* been corrected for extinction.

(1) Detection less than 3σ above background noise.

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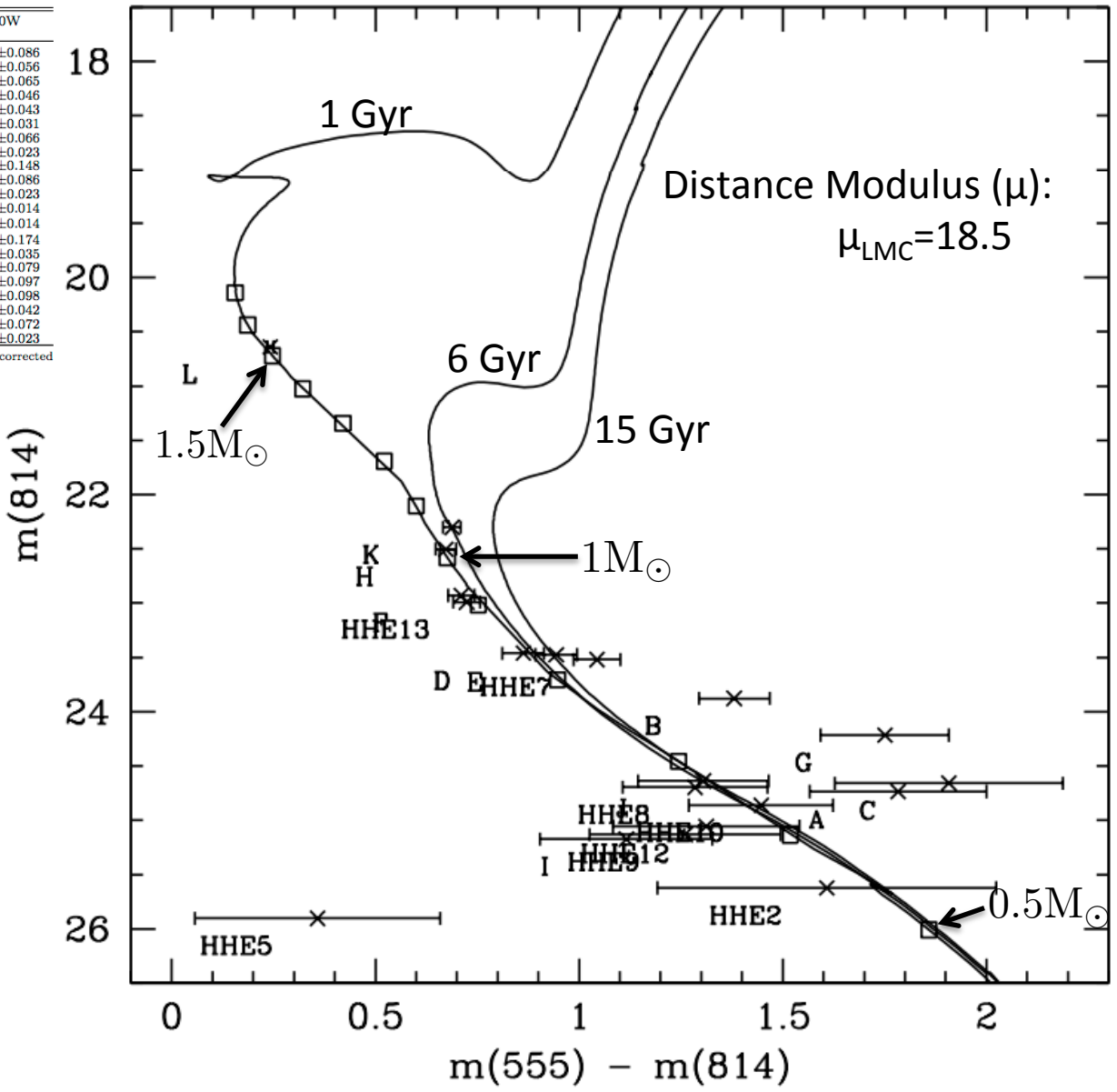

Conclusions

- Using hydrodynamic simulations and proper motion measurements we constrain our search radius and find 21 potential progenitor candidates
- Fitting isochrones to our photometry of these candidates, we find masses in the range of 0.5-1.5 $M_{\odot}$ for these stars
- We *cannot* rule out a SD progenitor system for SNR 0509-67.5!