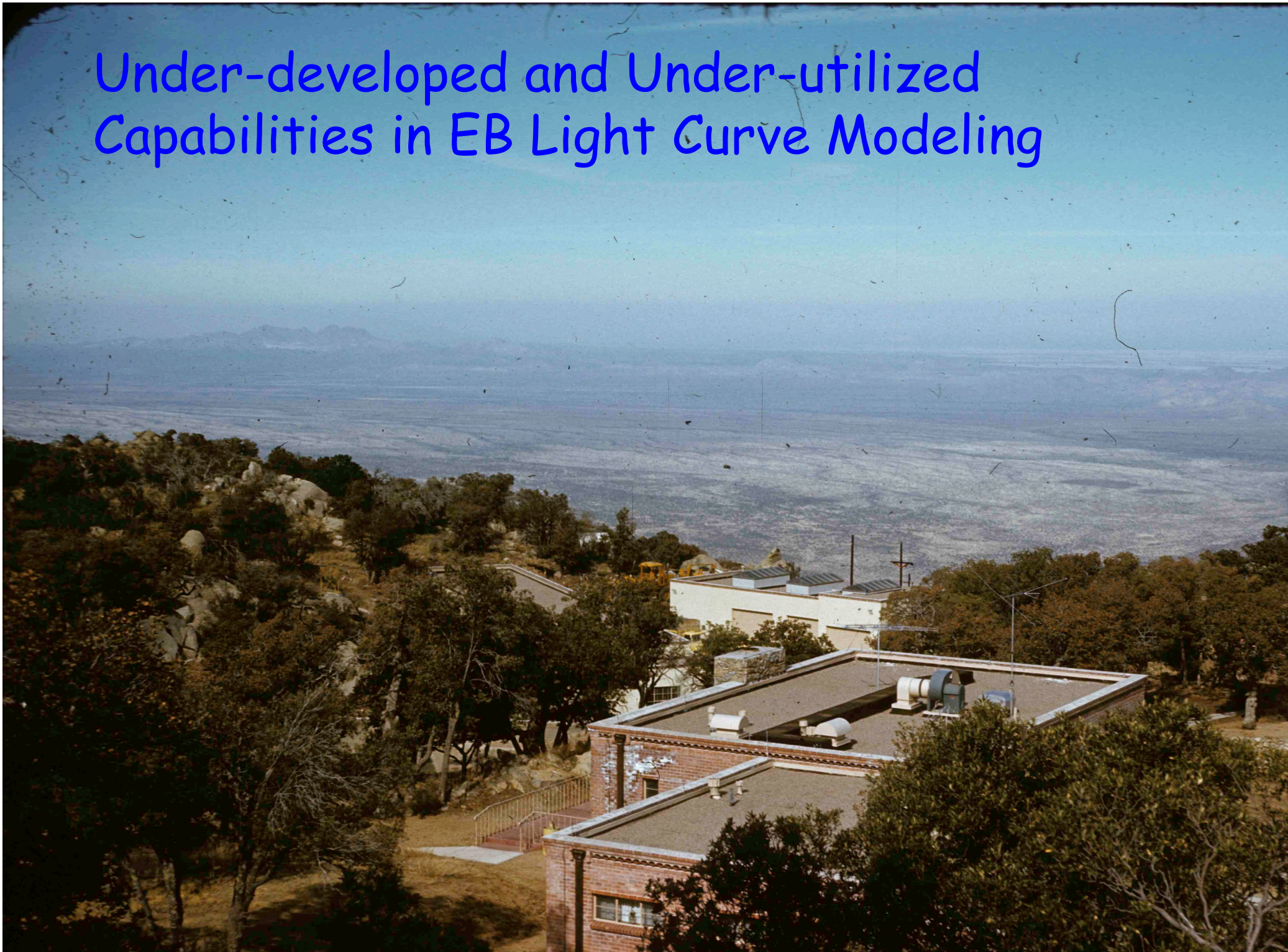
Under-developed and Under-utilized Capabilities in EB Light Curve Modeling



Growth and decay of magnetic starspots and spot groupings

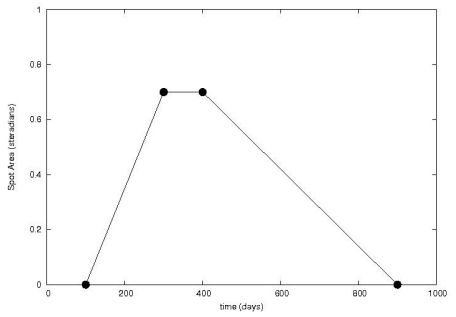
Looking for: Spot area vs. time - but not too detailed!

Sunspots are an obvious information source, but that's only one star.

And sunspots show a wide variety of growth & decay forms, so they are not likely close the book on "waveforms"

EB's, ellipsoidal variables, and rotating single stars offer information about timewise starspot development *as it depends on mass, composition, envelope rotation, and age.*

And why? : Results can stimulate theoretical work on outer convection zones and their dynamos.

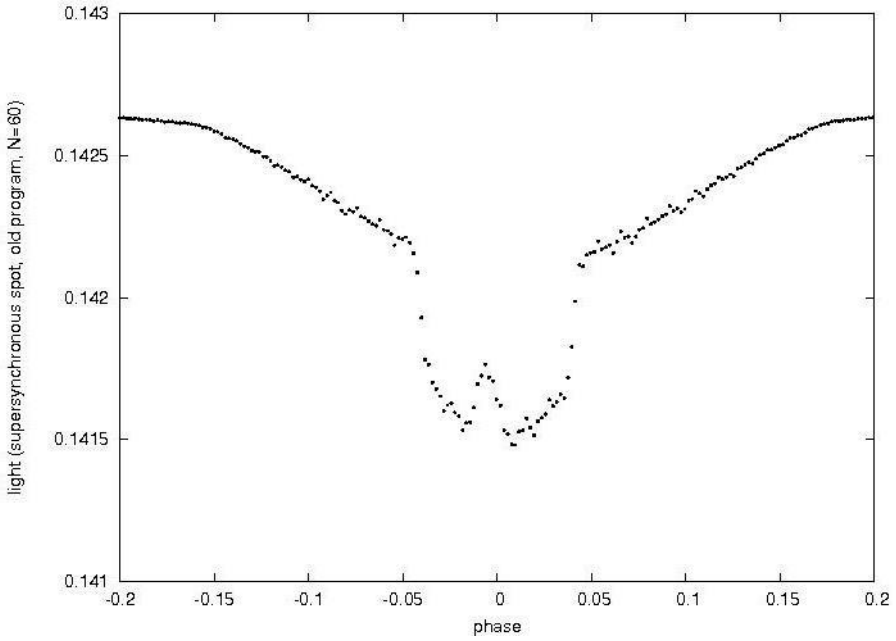


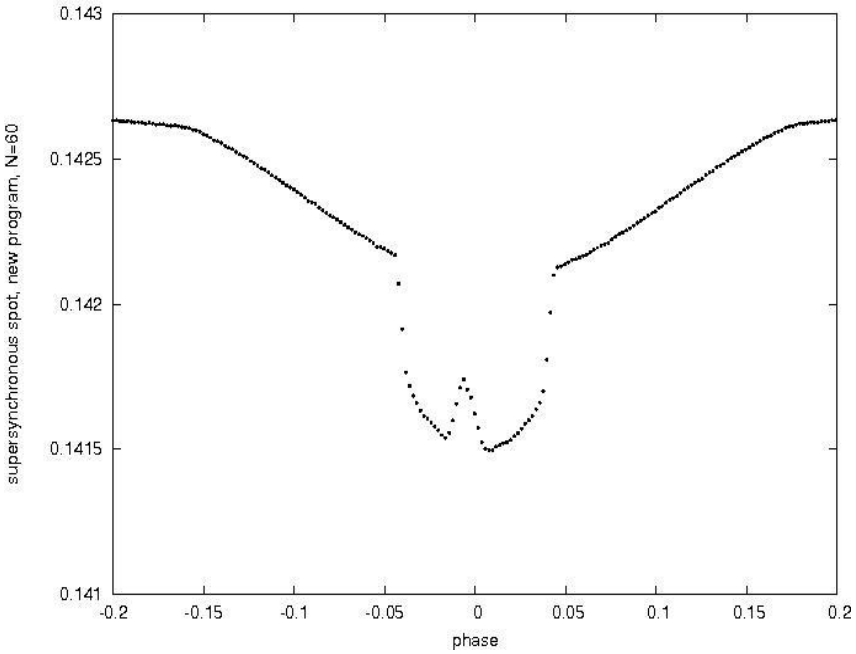
Long, ‘continuous’, data runs from where? : Kepler, Gaia, & automated telescopes.

The bad (old) news: Implicit spatial resolution of the observations is very limited. Many parameters.
The good (new) news: Advanced instrumentation, precise models, and impersonal solutions.

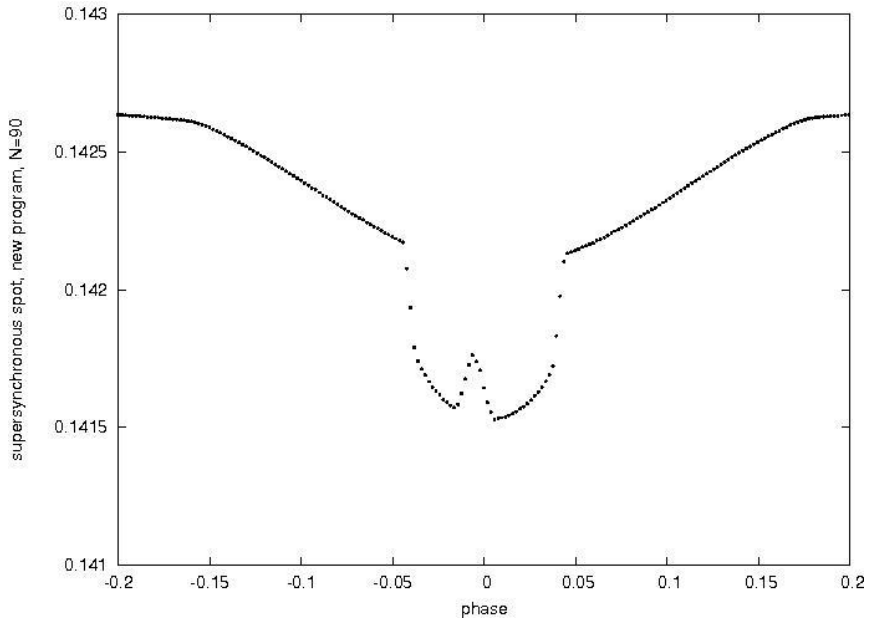
Stepping stones:
1. Refinement of spot geometry (irregularities)? No, but refinement of spot geometric treatment (numerical noise reduction via fractional areas).
2. Simple but informative growth-decay curves that can tell the essentials of spot aging without imposition of preconceived ideas (for now, growth-decay parameters are four times [onset, max 1, max2, disappearance. Area vs. time form is in straight line segments.]).

Experiments are underway (simulation solutions and real star solutions).
Will results really lead to understanding? Stay tuned!





Notice the greatly stretched vertical scale



Broadened Spectral Line Profiles

Moderately high resolution spectra are needed.

Binary system line profiles have been in the WD model for about 20 years (eclipses, tides, gravity brightening, etc.). Also blending.

Intrinsic broadening (damping, thermal Doppler, turbulence, etc.) can be added if there is interest. Potential useful output is connected with each effect. EB's give added stellar atmosphere information via line profiles for the same reasons that apply to light curves. It's like tomography, but done another way.

Simultaneous solutions with other data types could be optional, ensuring coherent results (perhaps this is the main benefit).

Too many parameters? Well, they don't all have to be done at once.

Ephemerides from Whole Curves and from Mixed Data Types

The usual data are: eclipse timings (many may exist, often where we have only one epoch of full light curves).

But then there are other circumstances: good light curves at two or three epochs, perhaps supplemented by radial velocities, with few eclipse timings (typical for recent discoveries).

Conversion of time interval to phase interval (Wilson, 2005):

$$\Delta\phi = \frac{\ln\left[1+\frac{(t-T_0)dP/dt}{P_0}\right]}{dP/dt}.$$

Included are dP/dt, third body kinematics, and apsidal motion, interacting with all the other parameters.

Future: expand whole curve solutions to include eclipse timings (must be careful about weights, but do-able).

Interstellar Extinction from Absolute Multi-band Light & RV Curves

Can it work? Well, it does in simulations (solutions of generated data). (Wilson, 2008; Wilson & Van Hamme, 2010)

So it's a success as a formal algorithm, but there's little experience with real binaries, where we get convergence to definite answers but don't know if the answers are right.

Much more experimentation is needed.

Circum-stellar Clouds and Streams (photometric applications)

An attenuation model (absorption and scattering) has been in WD for more than 10 years (two kinds of wavelength-dependent absorption. Also electron scattering).

The scattering material is at fixed locations in the rotating frame, but it could be made to move by adding an orbit integrator. Moving structures could then be worthwhile.

The only application so far is to AX Mon (Elias, et al., 1997), which has a big UV depression likely due to a self-intersecting stream.

Polarization curves (the black hole of EB publication)

Some EB's have potentially informative polarization curves, but data are scarce - close to non-existent (polarization data but almost no curves).

Some polarization effects are periodic, some not - yet there are papers where observation times are not published (only phases!) More common is no data publication at all - just pictures.

Analyses often involve the unnecessary step of Fourier fitting (requires judgments of how many terms to include, accomplishes nothing, and undermines proper computation of standard errors).

A model that avoids these shortcomings could be further developed if a reasonable amount of polarization curve data existed (Wilson & Liou, 1993).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