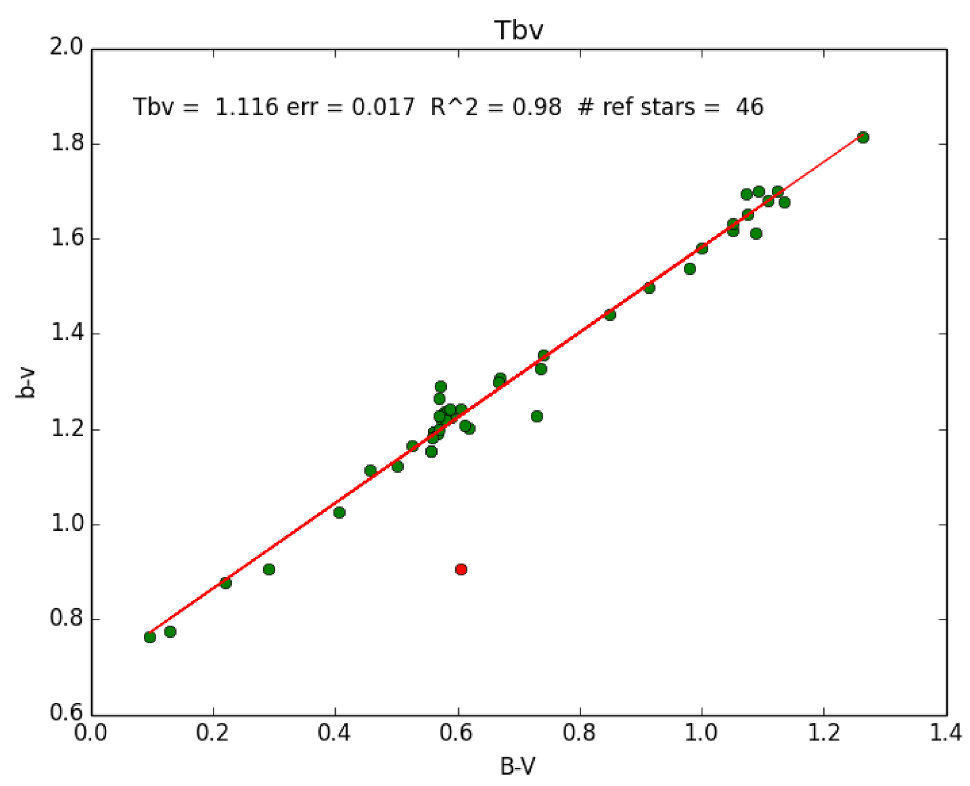
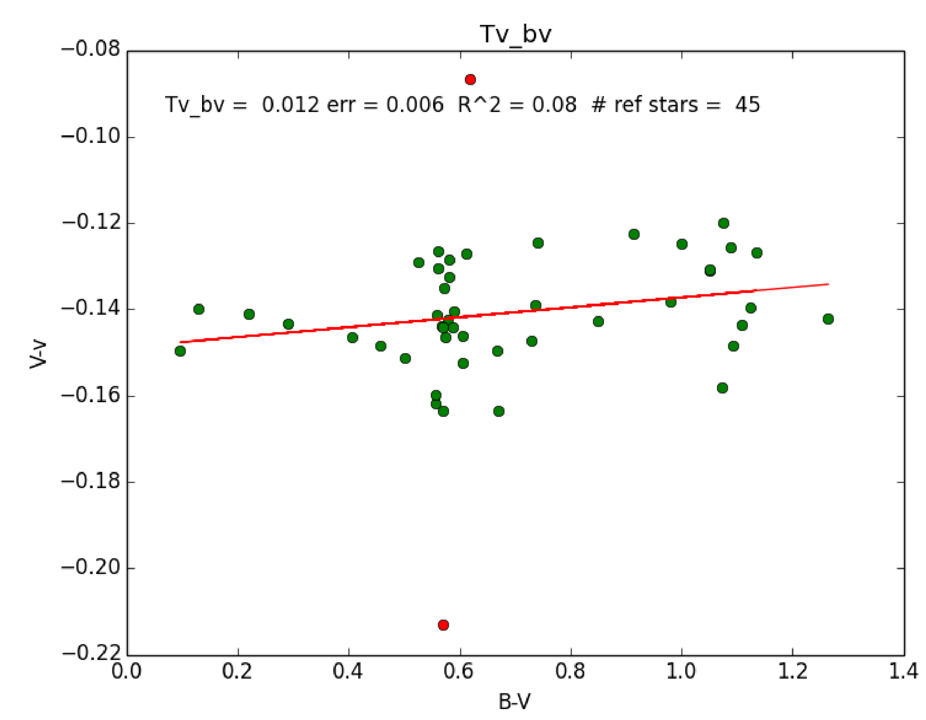
# Transforms: Making your data comparable with others

Your telescope optics and camera are unique. Your measurement of a star's magnitude will be different from another astronomer's measurement, even if conditions are identical, because of this uniqueness. For the two of you to have comparable data you both need to adjust, transform, your data to a standard system.

The AAVSO extended-file-format that we use to report data takes the first step by having you report a "standardized" magnitude: VMAG = (V instrumental - Comp instrumental) + Comp standard . This process takes you most of the way to a standard framework and allows you to share data in the Light Curve Generator. In fact, if the comp star has the same color as the target star, this formula will perfectly transform your data to the standard system. But given our small fields of view and the lack of choice of comps, you are unlikely to have target and comp with matching colors. The transformation process presented here takes you the rest of the way.

We define the uniqueness of our observing platforms by plotting our instrumental magnitudes against reference stars, stars for which we know the magnitude as if they were measured above the atmosphere. Here B and V are the standard magnitudes, b and v are the instrumental mags.




From this plot we extract the slope of the curve. This number, the transform coefficient, quantifies how your system is different and we will apply it to your observations to get to the standard framework.

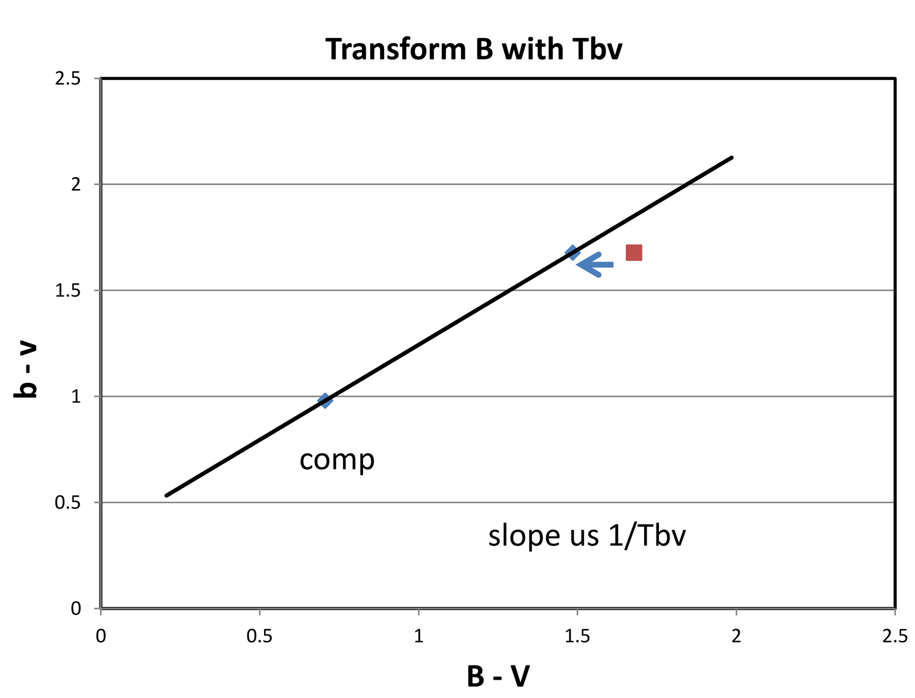
Let's work through an example of transforming an obs in B:

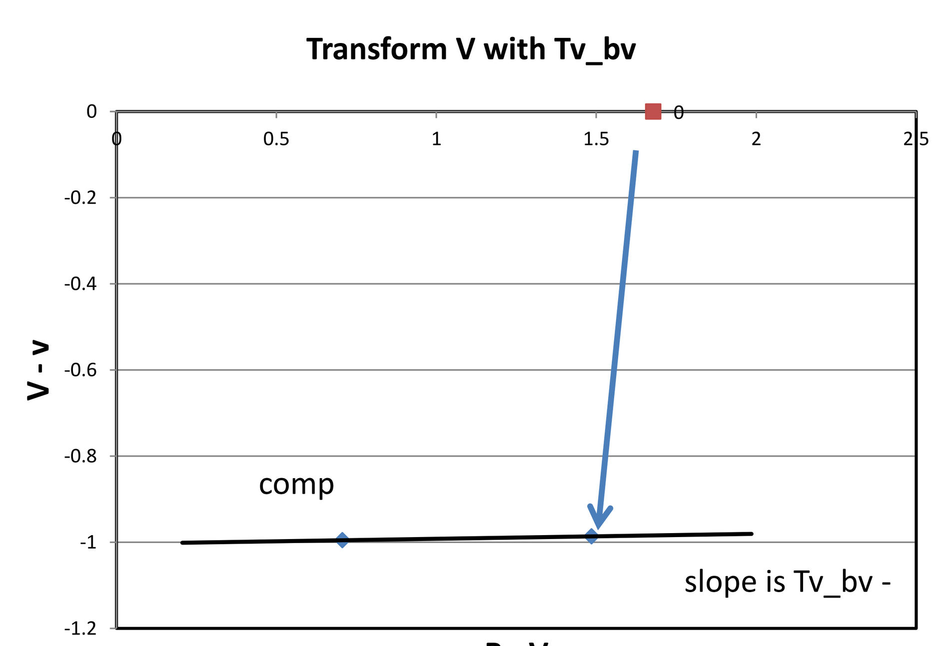
- variable notation: filter/star FS. Upper case filter is reference or transformed, lower case is instrumental. Star s is the target, c is the comp.
- By definition Tbv = ((Bs-Vs)-(Bc-Vc)) / ((bs-vs)-(bc-vc)) (1)
  Transforming is finding the Bs and Vs that will satisfy equation (1) with our own Tbv.
- Rearrange (1) to Bs= Vs + (Bc-Vc) + Tbv * ((bs-vs)-(bc-vc)) (2)
- Since the equation involves the V filter we need a V observation to be transformed along side. Transforming is always done with "grouped" observations in this fashion to resolve the simultaneous nature of the equations
- Let's use Tv_bv to resolve Vs:
  Tv_bv = ((Vs-vs)-(Vc-vc)) / ((Bs-Vs)-(Bc-Vc)) (3)
  Vs = vs + (Vc-vc) + Tv_bv * ((Bs-Vs)-(Bc-Vc)) (4)
- Looking at equations (2) and (4) it appears that you have a lot of algebra to do to isolate the Bs and Vs terms that you want for a result. But there is an easier way. This is a linear system which will converge to the correct result. Start with a guess for Bs and Vs, say Bs= bs and Vs= vs, and simply run through the two equations 3 or 4 times. You will find that Vs and Bs arrive at stable values. These are your transformed magnitudes that along with your instrumental observations satisfy you coefficient model of the Standard system.

The key point here is that the iteration process avoids a morass of algebra or the complexity of setting up matrix equations. And this is easily extensible to 3 or more filters: For each filter you need a coefficient that implies an equation. And keeping the equations simple makes it easy to compute the final error. You could do this in Excel, though using the TransformApplier application is easier!

Here is a visualization of what the transform process did. The arrows show how the iteration process finds its solution on the line that defines the standard system for your unique scope. Note too that the standard line is anchored by your comp star observation.

The change looks large, but keep in mind that this shows instrumental mags.
bs= 10.964, b std= 9.224, Bs= 9.314 so the transform change to your VMAG is 0.090 in B
vs= 9.151, v std= 7.820, Vs= 7.829 and 0.009 in V

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