Beyond Solar Twins

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1 Introduction

Why search for stars which are identical solar twins? Note that

- such stars may not exist, and
- one might not need them to begin with.

Let's consider the second of these ideas.

Suppose one wants to determine the value of a solar color index—say, $(R-I)_C$ in this case. One way to proceed is as follows.

1. Assemble data for stars with values of θ and $(R-I)_C$.
2. Use those data to determine a relation between θ and $(R-I)_C$.
3. Using the solar value of θ, read $(R-I)_C$ for the Sun from the relation.

Note that a fictitious solar twin is defined by a point on the relation. [An illustrative relation is given in Fig. 1. Plotted values of θ are from Saxner & Hammarbäck (1985, A&A, 151, 372).] The relation, in turn, is obtained from data for a number of stars. For best results, one

1. makes that number of stars reasonably large, and
2. chooses stars with a range of temperatures.

But if one were to use an ideal solar twin instead, one would

1. compare the Sun to only one star, and
2. choose a star which has exactly the same temperature as the Sun.

So if one insists that a solar twin must be a real star and not a construct from a graph, *one has tacitly repudiated the use of real solar twins* in this case. Remember also that points (1)—(3) are an example of a technique which is well accepted. Since repudiating the use of real solar twins is already a *tacit* part of that technique, perhaps it would help people's thinking to make it an *explicit* part instead.

Now consider another problem. Suppose "star A" is known to *resemble* the Sun, but is not *identical* to the Sun. Let the following differences be obtained spectroscopically.

1. $\Delta[\mathrm{Fe/H}] \equiv [\mathrm{Fe/H}]_\odot - [\mathrm{Fe/H}]_A$.
2. $\Delta[\mathrm{CNO/Fe}] \equiv [\mathrm{CNO/Fe}]_\odot - [\mathrm{CNO/Fe}]_A$.
3. $\Delta(\log g) \equiv (\log g)_\odot - (\log g)_A$.
4. $\Delta\xi \equiv \xi_\odot - \xi_A$.

Using those differences, let a function

$$\Delta m(\lambda) \equiv m(\lambda)_{\odot} - m(\lambda)_A \tag{1}$$

be obtained by differencing two synthetic spectra. This function has a resolution which is higher than any used in photometry or spectrophotometry, and it is published for general use in both kinds of observing.

To show how the function is to be applied, consider observers who are determining asteroid albedoes using filter photometry. Presumably those observers would compare their asteroid measurements to measurements of a real solar twin if such a thing were available. Instead, those observers now measure star A. Using results obtained by integrating $\Delta m(\lambda)$ over their passbands, they then convert their measurements of star A to measurements of a fictitious star A' which is identical to the Sun. They then compare their asteroid data to their results for star A'.

To generalize this idea, let standard stars A, B, C . . . be chosen so that one of these stars is always available to an observer in either hemisphere. Let a function $\Delta m(\lambda)$ be determined for each star. The observers may now recover measurements of fictitious solar twins A', B', C' . . . . The consistency of those measurements can then be used to find out how well the use of fictitious solar twins is working. If all goes as it should, the results for the fictitious solar twins will be consistent because the original stars were not too different from the Sun to begin with.

With these specifics in mind, a conjecture can be advanced (in the spirit of conjectures by mathematicians about unproved theorems):

By constructing fictitious solar twins in the ways described (and possibly other ways as well), one can make it unnecessary to search for real stars which are **identical** *to the Sun.*

I invite readers to talk to me about support or disproof (especially disproof) for this conjecture.

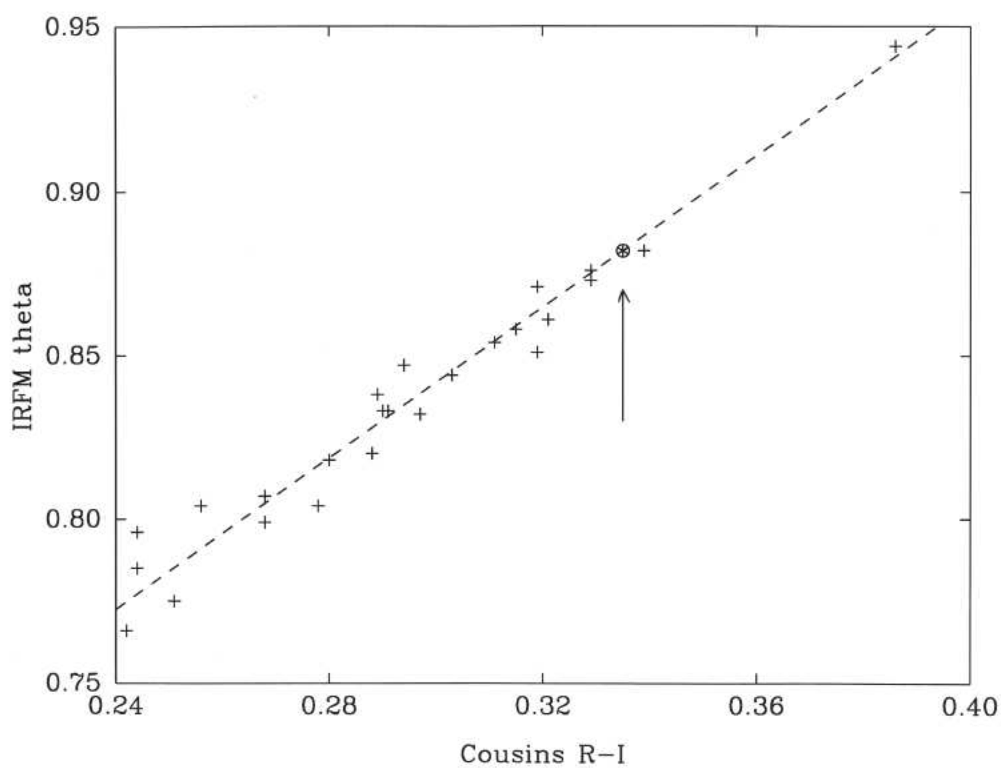

Figure 1.