On the Possibility of Selecting Quasi-Stellar Galaxies from Blue Stars by Observations in the Near Infra-Red.

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It is known that a certain fraction of the high-galactic-latitude, faint, blue «stars» are objects with the same optical properties as the quasi-stellar sources (1), but with much smaller radio luminosity (2,3).

The criteria that have been used by SANDAGE and LUYTEN (4) in order to obtain a fair list of candidates for further spectroscopic examination are the following:

1) no measurable proper motion,
2) colors above the black-body line in the $U-B$, $B-V$ diagram,
3) optical variability.

About half of the objects satisfying the first criterion, and either the second or the third, have been found by SANDAGE to be quasi-stellar galaxies on the basis of spectroscopic examination. In fact, the proper-motion criterion, with the best observational material available (15 years time base-line from the original Palomar Sky Survey to recent second-epoch plates), does not lead to the rejection of all the galactic objects. The proper motions of some white dwarfs and of all the high-absolute-luminosity stars (at the very faint magnitudes we are concerned with) are too small to be detected.

The second and third criteria help to increase the frequency of good objects in the list of the candidates, but within the objects under the black-body line, which have shown no light variation in the material examined and that are dropped, certainly exist some good candidates.

It is known, on the other hand, that the over-all, broad-band properties of the optical spectrum of quasi-stellar objects show a fairly small dispersion, and SANDAGE (5) has constructed an «average

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spectrum for the QSO's for using the \( U, B \) and \( V \) photometry of objects having different red-shifts. This composite spectrum is essentially different from the spectra of stars. The emission of stars, particularly of the high-temperature stars that can be confused with the quasi-stellar objects on the basis of \( U, B \) and \( V \) photometry, is closely approximated by a black-body spectrum. The composite average spectrum of QSO's is on the contrary much more flat (i.e., its extension in frequency is much larger than that of a black-body spectrum).

Figure 1 shows the average composite spectrum of QSO's plotted for a red-shift of two, and compared with a black-body spectrum for 12000 °K, the temperature that gives the best fit to the quasar spectrum in the \( U, B \) and \( V \) colors. The black-body curve, therefore, represents the spectrum of the stars that can be confused with quasars of red-shift two, on the basis of \( U, B \) and \( V \) photometry.

It is seen that at 8000 Å, the mean emission of the quasars having red-shift two is a factor 2.4, or 0.95 magnitudes, stronger than the corresponding black-body line. No data exist on which to base a prediction for red-shift substantially larger than two. On the other hand, from the composite spectrum, the infra-red excess becomes negligible for \( z < 0.5 \), but at \( z = 1 \) it is still a factor 1.9, or 0.7 magnitudes, if the \( U-B \) color is used for comparison. It should also be considered that many objects are more powerful in the infra-red than Sandage's composite spectrum shows. Particularly none of the objects studied by Oke (*) should have been missed on the basis of the infra-red excess.

A preliminary test has been conducted with the 48-inch Schmidt telescope of Palomar Observatory. A two-color, \( U \) and \( B \), plate and an infra-red plate (I-N emulsion sensitized in water and exposed through Wr. 88B + OR1 filters) have been obtained of a field near the

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{spectrum.png}
\caption{The average composite spectrum of QSO's plotted for a red-shift of two (---) and the 12000 °K black-body spectrum (-----).}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{composition.png}
\caption{Composition of the \( U, B \) and \( I \) images for two objects. The lower one is a star, the upper one a suggested quasi-stellar galaxy. Notice how strong its infra-red image appears, although the star shown for comparison is quite a reddish one.}
\end{figure}