A SEARCH FOR METEOR SPECTRA FROM METEOR SHOWERS ASSOCIATED WITH S-TYPE NEAR-EARTH ASTEROIDS. K.L. Reed and M.J. Gaffey, Dept. of Earth and Environ. Sci., Rensselaer Polytechnic Institute, Troy, New York 12180-3590 USA.

Theoretical and dynamical work has shown that meteoroid streams should be produced by asteroidal collision processes and various investigators have found evidence for the existence of meteor streams associated with near-Earth asteroids [1,2,3,4]. The present project coordinated amateur astronomers from around the world in an attempt to obtain atmospheric-entry spectra of meteors from two meteor streams that have been associated with S-type asteroids (the Daytime Arietids with 1566 Icarus [May 29-June 19] and the Zeta Perseids with 1984KB [June 1-17]).

High resolution atmospheric-entry spectra can be interpreted to determine the abundances of a number of elements present in a meteoroid [5]. Low resolution spectra cannot provide accurate elemental abundances, but can indicate the presence of certain critical elements which can be utilized to test whether or not their S-type asteroids source bodies are differentiated objects. Compared to an undifferentiated meteorite (chondrite), there are major elemental abundance heterogeneities in differentiated meteorites. For example, at the gram scale there is relatively little compositional variability within individual chondrite specimens [6], and even at the milligram scale (e.g. 1 mm fragments) most compositional variability is within the order of a factor of a few. By contrast, differentiated meteorites commonly show large elemental depletions or enrichments compared to chondrites, and at gram scales commonly consist of a single mineral phase.

Telescopic spectral investigations indicate that most large mainbelt S-type asteroids are differentiated objects similar to stony-iron meteorites [7]. However this conclusion is strongly disputed among the meteoritic and dynamical communities who believe that many of the S-asteroids must be similar to ordinary chondrites [8]. Meteor spectra of showers associated with S-type near-Earth asteroids provide a means of testing whether S-objects are differentiated or chondritic. For a chondritic body, fragments in the common meteor mass range (milligrams to grams), should exhibit only comparatively small variations in the abundances of elements such as iron, magnesium and calcium. By contrast, fragments in this same mass range from a stony-iron body should have a strongly bimodal compositional distribution (silicate grains and NiFe metal grains with relatively few mixtures). Meteoroids composed primarily of silicates produce low resolution atmospheric-entry spectra showing strong lines of Ca and Mg or Ca, Mg and Fe (Millman Type X and Y meteor spectra, respectively [5]). Meteoroids that are primarily Fe-Ni metal produce low resolution spectra with only strong Fe lines (Millman Type Z meteor spectra.) Thus the meteor spectra from a shower associated with a differentiated S-type asteroid should show a bimodal distribution of meteor spectra (subequal numbers of Z and X-Y spectra) while those from an undifferentiated body should be primarily X-Y spectra with few Z-type.

Deriving statistics on the spectral types within such a meteor shower would test the hypothesis that these S-asteroids are differentiated objects.

Response to a request for participation in a meteor spectroscopy project [9] was outstanding, with 69 amateur astronomers in 11 countries attempting to make the observations. Due to budgetary constraints, only inexpensive transmission gratings could be provided along with the needed film and instructions on how to obtain meteor spectra. The tabulated zenith hourly rates (ZHR) for the Arietids (60) and for the Zeta Perseids (40) are among the highest for all meteor showers, but the observing conditions are
unfavorable. Their radiants are located approximately 15° apart and are at essentially the same declination as the Sun. The westernmost (the Arietids) rises only an hour prior to the beginning of astronomical twilight for equatorial latitudes and after the beginning of astronomical twilight at latitudes above 45°. Thus observations are restricted to latitudes 40°N-40°S and to only a short period just prior to sunrise. The low altitude of their radiants during the observing periods produces an actual hourly rate well below the ZHR, increasing from zero at radiant rise to about 0.2%ZHR at the beginning of astronomical twilight. Observers were provided with camera pointing directions and tables which indicated the time of radiant rise on each day for their specific latitudes. Although the shower durations are indicated as 5/29-6/19 and 6/1-6/17, respectively, the presence of the moon prevented useful observations prior to June 12th but relatively good coverage was obtained for the remaining shower periods.

With an approximate total of 25.8 steradian-hours observed, results included photographs of aircraft lights, automobile headlights and satellites but only 6 meteors. These meteors were not associated with either shower radiant and no spectra were obtained due to the faintness of these meteors and to the low efficiency of our gratings. Since the photographic systems being used should record many more meteor trails than meteor spectra, the absence of meteor trails from the radiants of these two showers indicates that they were not active during the period of our observations. We suggest several possible explanations for these results:

1) The meteor streams were very short-lived and may no longer exist.
2) The meteor showers are of short duration (at least in 1991) and occurred during the moon-lit period prior to the start of our observations.
3) The meteor streams are extremely "clumpy" and observers were not present at incoming meteor positions.

The empirical evidence of previous workers along with dynamical theory, gives the latter two more credence than the first. Continuing work in this area should utilize amateurs to the fullest extent as they were knowledgeable and helpful in all aspects of the project. Their efforts were limited by the low efficiency gratings provided due to the project's limited budget.
