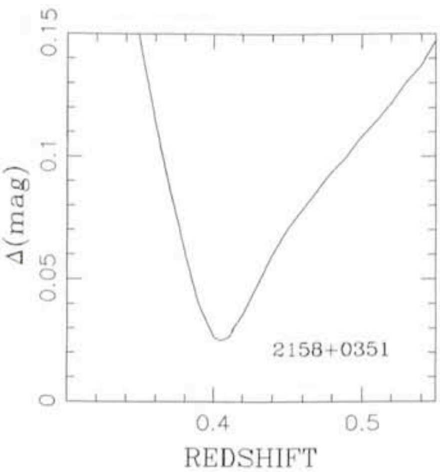

Figure 8: *The photometric determination of the redshift of the cluster 2158 + 0351. Displayed is the merit function which minimizes the difference between the colours (g-r) and (g-i) of the elliptical galaxies detected and those predicted by the evolutionary model of Figure 7.*

our diagram and of the luminosity function of the clusters obtained via an accurate multicolour photometry may provide an effective method (a) to discriminate galaxy morphology, (b) to evaluate their intrinsic evolution and (c) to estimate redshift with an accuracy of ± 0.05. We emphasize that two main requirements have to be fulfilled in order to reach such a fair resolution in exploring the universe at large distances:

(i) we need to observe clusters instead of field galaxies to be able to recognize them with high statistical confidence;

(ii) we need a combined comparison with evolutionary models, in order to properly account for the intrinsic photometric properties as we use galaxies as standard candles in the cosmological framework.

Such an approach is also preparatory to more detailed studies using the new generation telescopes (VLT) and will be complemented by deep surveys on selected fields possibly supported by spectrophotometric work.

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Trojan Search at ESO

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Doing minor planet research is sometimes considered a proof of bad taste among astronomers. It is a fact that asteroids, these rocky pieces between the orbits of Mars and Jupiter, have lost much of their interest, now that most of the larger ones have been catalogued: their orbits are well known, their chemical structure has been studied and their rotation properties investigated. Hence, chasing the smaller kilometer-sized members does not seem a useful occupation. Indeed, why should they be different from the larger ones?

I got engaged in asteroidal work in May 1986 (first GPO mission at ESO). Since that time my interest in asteroids has grown rapidly. In March 1988 I attended the "Asteroids II" conference in Tucson, Arizona. There I was really impressed by the wealth of possibilities in the field of minor planet research.

My primary interest are the Trojan asteroids, these objects that are describing their orbits at a mean distance of 5.2 A.U. from the Sun, i.e. at the 1 : 1 commensurability with Jupiter.

It is known from celestial mechanics that the problem of three bodies does not, in general, admit a finite solution in terms of known functions. Joseph Louis Lagrange (1736–1813), however, has shown that there is a solution in the special case that the three bodies (Sun, larger planet, asteroid) are moving in a fixed plane at equal distances from each other (triangular configuration). It is assumed that the mass of the third body (the asteroid) is negligible (Fig. 1).

The first object of this kind was found in 1906 at the Observatory of Heidelberg. The discoverer was the famous Max Wolf, and for some reason, he called his newly discovered asteroid "Achilles", after the hero from the Trojan war.

With the discovery of Achilles, a theoretical problem found an observational confirmation. Since then, more minor planets have been found at the so-called libration point L_4 and L_5 and all have been called after the heroes of Homer's Ilias.

It is interesting to note that we find only "real" Trojans (Priamus, Aeneas, Anchises . . .) at the libration point L_5 (preceding point) and Greeks (Achilles, Nestor, Agamemnon . . .) at L_4 (following point). This is of course a consequence of the appropriate naming convention.

However, one Trojan (Hector) is at L_4 and one Greek (Patroclus) at L_5. The motion of a Trojan is very complex, it will not remain constantly at L_4 or L_5; small changes from the triangular configuration will result in oscillations around these points. The theory of predicting

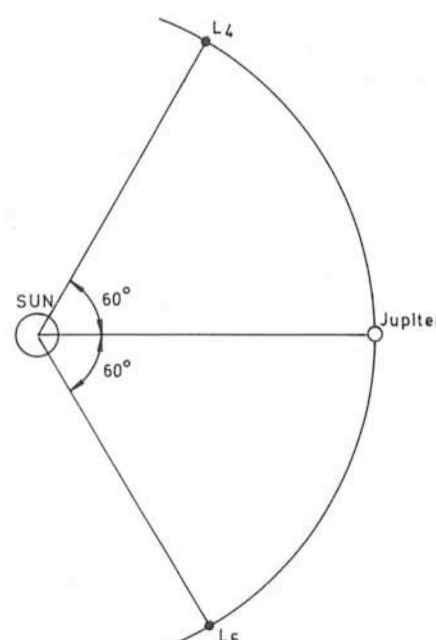

Figure 1: *Triangular configuration.*

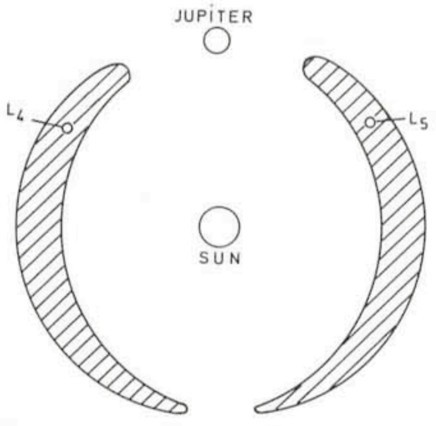

Figure 2: *Oscillation zones around the libration points.*

the exact oscillation amplitudes and frequencies is difficult, and much work has still to be done (Fig. 2). Observation and discovery of new Trojans is therefore highly important.

Since the mean distance from the Sun is about 5.2 A.U., the mean motion of a Trojan is almost 1/3 of the mean motion of main belt asteroids. In order to detect their trails on the GPO plates, it is therefore necessary to expose them much longer which is rather time consuming. Another way to discover them is by taking two plates in succession. Blinking of the plates may then reveal the unknown objects.

I must confess that I do not understand why asteroidal research has such a bad quotation among astronomers. During the last two years since I got involved in this kind of work, this occupation grew out to a real passion. The "infinite minor planet game" of Kohoutek became for me a most fascinating reality (see below).

From the point of view of observational work I may mention the following: in 1986 I discovered the Trojan object 1986 VG_1 at the observatory of Haute-Provence and in 1987 at ESO the Trojan objects 1987 QN, 1987 YT_1 and 1987 YU_1. But there are more interesting objects. In September 1986, I observed the long lost planet Nolli (473) at the Bulgarian National Observatory. Since it was not recognized as such, it received from the Minor Planet Center in Massachusetts a new provisional designation (1986 PP_4).

In September 1987, I discovered the Apollo object 1987 SB in collaboration with the Bulgarian astronomers at Rozhen. The object was followed at various observatories up to the 15th of January 1988. This object (a = 2.20 A.U.) is characterized by a very high excentricity (e = 0.66) and a low inclination (i = 3°). It therefore can approach three planets to within less than 0.050 A.U.: Venus (0.023 A.U.), Earth (0.045 and 0.052 A.U.) and Mars (0.019 and 0.034 A.U.). It means that 1987 SB has 5 possibilities of close encounters to these planets, which makes it rather "dangerous" on long terms. The diameter is of the order of 2.5 km (*l'Astronomie,* May 1988, p. 192). I could recover the object on a plate taken by Oscar Pizarro with the ESO-Schmidt in November 1987.

Other interesting objects (from the point of view of resonance studies) are the Phocaea objects (1987 BO_1 discovered at ESO; 1987 CR, discovered at Haute-Provence), and the Hungaria objects (1988 BJ, discovered at Haute-Provence, 1988 CR and 1988 CM_3, discovered at ESO; 1 prediscovery at the Bulgarian National Observatory at Rozhen: 1987 SJ_3) (Fig. 3).

The positions of the Hungaria object 1987 SJ_3 were sent too late to the Minor Planet Center and E. Shoemaker at Mount Palomar got away with it (even when he discovered it 4 days later), but that's part of the game.

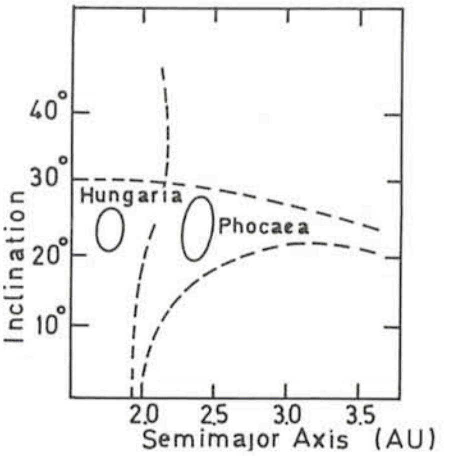

Figure 3: *The Hungaria and Phocaea asteroids.*

Music for Asteroids

Nausikaa, the lovely person from the Odyssey, inspired me to compose for the piano the suite "Asteroid 192". The Trojan hero Odysseus, I have commemorated in the "Odysseus suite". The first performance of the Nausikaa suite took place in September 1986, at the town of Plovdiv (Bulgaria), not far away from the Greek border, before a small audience of Bulgarian astronomers. The Odysseus suite, I played for the first time at the home of Dr. R. Binzel, Tucson (Arizona), in March 1988.

Figure 4: *The Phocaea asteroid 1987 BO_1, discovered at ESO (January, 22, 1987).*