This is the scientific report concerning the activities carried out by Dr. Alberto Cellino during his 8-week visit at the Observatoire de la Cote d'Azur, funded by ESF in the framework of the ESF activity entitled Gaia Research for European Astronomy Training (GREAT). The title of the project approved by ESF was "The determination of the geometric albedo of asteroids from Gaia data".

The purpose of the Dr. Cellino's visit in Nice was to collaborate with Dr. Paolo Tanga (OCA) on a research program aimed at improving the capability to derive from future Gaia observations of asteroids some reliable information about the albedo of these objects. The albedo is an important physical parameter per se, because it is directly related to the mineralogical composition and to the texture of the surface. Moreover, the albedo is an important parameter for the purposes of improving the development of a taxonomic classification of the asteroid population based on spectro-photometric data. It is known, in fact, that spectro-photometric data covering a range of wavelengths corresponding to those which are expected to be obtained from the Gaia detectors (from blue to red), can be used to subdivide the asteroid population in a number of different taxonomic classes.
Some of these classes, however, correspond to objects having quite different surface compositions, which can be distinguished only having at disposal some estimate of the surface albedo.

The determination of the albedo, however, is not an easy task, and the visit of Dr. Cellino in Nice had as a primary objective the analysis of this problem, taking into account the kind of information that Gaia is expected to obtain based on the mission instruments and detectors. In particular, Gaia will observe asteroids when they are far from solar opposition, making it particularly difficult to derive very reliable estimates of the absolute magnitudes of the objects. We remind that the absolute magnitudes of the asteroids are defined as the magnitudes which would be measured by observing the objects at unit distance from both the Sun and the Observer, and at perfect solar opposition. A well-known relation links the absolute magnitude of an asteroid with both its size and its albedo, a fact which can be exploited to derive the albedo having at disposal measurements of the size and absolute magnitude (or, *viceversa*, to derive the size if the albedo and the absolute magnitude are known). Unfortunately, however, Gaia will not have aboard any thermal IR detector, which would be useful to derive asteroid sizes even for quite faint objects. Given its high resolution limit, Gaia will have the possibility to directly measure the sizes of objects larger than about 30 km, but these represent only a fraction of the order of 1%, or less, of the total population of asteroids observable down to the magnitude limit of the Gaia detectors. For this reason, some other approach must be developed in order to derive the albedos of a much larger fraction of the asteroids which will be observed.

The approach currently developed by Dr. A. Cellino, who is responsible of the determination of asteroid physical properties for the Gaia Data Processing and Analysis Consortium (DPAC) is that of exploiting some relation which has been found to exist between the asteroid albedos and the observed variation of apparent magnitude as any given object is observed in different illumination conditions. In particular, it is known that asteroids exhibit a variation of magnitude as a function of the so-called phase angle characterizing any observation epoch. The phase angle is defined as the angle between the directions to the Sun and to the observer as seen from the asteroid. A phase angle of 0 degrees corresponds therefore to ideal solar opposition. Ground-based photometric campaigns have shown that, before and after opposition, the magnitudes of the asteroids vary as a function of the phase angle. The obtained phase-magnitude curves are characterized by a non linear surge close to opposition, at phase angles which will not be covered by Gaia, and by a linear trend at phase angles larger than about 7 - 8 degrees.
The slope of this linear trend will be measured having at disposal the sparse photometric observations obtained by Gaia for each object. We remind that, on the average, every main belt asteroid will be observed by Gaia a number of times of the order of 60. In 2000, Belskaya and Shevchenko published a paper (Icarus 147, 94-105) in which they showed that some relation exists between the photometric slope just mentioned above, and the albedo. This opens new prospective for the derivation of the albedo from Gaia observations, because the photometric slopes will be measured by Gaia for a large number of objects, of the order of several tens of thousands.

The work carried out by dr. Cellino during his GREAT-funded visit in Nice was to analyze with Dr. Tanga and other Nice colleagues the details of this possible approach, in particular in terms of reliability of the expected results. There are in fact some problems to be solved. First, the relation between photometric slope and albedo found by Belskaya and Shevchenko is not so strict and sharp as one could desire. This relation was based on the data available for a fairly small sample of objects. Moreover, while the magnitude-phase curves of these objects were overall very reliable, the same cannot be said for what concerns the albedos of these objects. In other words, we need a better calibration of the photometric slope versus albedo relation, and to accomplish this task, the major problem is to have at disposal accurate albedos for the maximum possible number of objects for which good phase-magnitude curves are available.

During the two months of the visit, it was decided that the use of albedo values derived from thermal radiometry are not suitable, because they are too uncertain, as shown by a comparison of asteroid albedos obtained recently by the WISE and Akari satellites. It was therefore decided to use albedo values obtained by means of polarimetric observations. This technique is based on a relation which is known to exist between the albedo and some parameters describing the variation of the degree of partial linear polarization of the sunlight scattered by asteroid surfaces in different illumination conditions, described, again, by the value of the phase angle.

Dr. Cellino and Dr. Tanga undertook a comprehensive analysis of the state of the art in asteroid polarimetry, by analyzing the existing phase-polarization curves of all asteroids observed so far, including also a sample of still unpublished data personally obtained by Dr. Cellino during some recent observing campaigns.
The result of this analysis was, on one hand, a new assessment of the classical relation used in the past by many authors to derive the albedo from polarimetric data, in particular, from the slope of the phase-polarization curve around the so-called inversion angle, the value of phase at which a transition is observed between the orientation of the plane of polarization of the scattered sunlight.

At the same time, an analysis of the data, including attempts to fit available phase-polarization curves by means of a superposition of an exponential and a linear component, opened new lines of investigation, because it is possible that the classical relation between polarization and albedo adopted in the past could now be expressed in a different way. The work on this important problem is just started now, and will continue after the end of Dr. Cellino's visit in Nice.

The results of the work done during Dr. Cellino's visit at the OCA are therefore interesting and can lead to further developments, in particular in terms of a better exploitation of future Gaia observations of asteroids.

During his visit at the OCA, Dr. Cellino gave also a seminar on the general subject of asteroid polarimetry, in order to provide an opportunity for many students to be informed on the state of the art of this discipline.