The most important scientific results of the project:

1. Exoplanet research

1a Discovering new transiting exoplanets: through ground-based spectroscopic observations of transiting exoplanet candidates, we have contributed to the discovery of three new transiting exoplanets (HAT-P-27b, HAT-P-31b,c and Kepler-16b). The highlight is the complex system of Kepler-16, whose discovery was published in the September 15th issue of the Science magazine: here a Saturn-sized transiting exoplanet was found around a close binary star. By chance alignment, the planet transits both components of the eclipsing binary central star, hence four different eclipses are visible in the ultra-precise observations of the Kepler space telescope. This is the very first confirmed circumbinary planet with accurately measured radius and well-constrained mass and density. Since the planet's orbital plane is aligned within 0.4 degrees to that of the central binary, its formation must have occured in a circumbinary protoplanetary disk. Kepler-16 represents a strong indication that planet formation is a natural companion to star formation in single and binary systems. Publications: 4, 6, 8.

1b Transit timing in HAT-P-13: we have organised a multi-site campaign to detect the hypothetic transit of the known second planet in HAT-P-13. The results excluded at high significance that the outer planet could also be transiting. Further follow-up observations with the 0.6m Schmidt telescope at the Piszkéstető Station revealed a significant shift in transit timing of HAT-P-13, presenting one of the few convincing cases of the Transit Timing Variation (TTV) phenomenon. Transit monitoring of HAT-P-13 in the coming few years will be important to measure the period of the TTV and thus constraining the physical mechanism causing it. Publications: 1, 13.

1c Orbital obliquity in KOI-13: we have detected and successfully explained the asymmetric Kepler light curve of the transiting exoplanet candidate KOI-13. Here the central star is transited by a substellar companion, a brown dwarf or a massive hot Jupiter. The Kepler data indicate an oblique orbit for the companion, detectable from an inclined transit in front of a non-uniform stellar disk. The latter is caused by the gravity darkening of the rapidly rotating star. Our investigation has demonstrated that orbital obliquity can be detected without measuring the Rossitter-McLaughlin effect from spectroscopic observations, which opens a whole new avenue for studying the statistics of strong dynamical interactions in exoplanetary systems. Our study led to a successful Director's Discretionaly Time proposal on the 2.6m Nordic Optical Telescope on the Canarian Islands for high-resolution spectroscopy of a transit in mid-August, 2011. The new data are currently being analysed. Publication: 20.

1d The “sub-Jupiter desert”: a cluster analysis of 106 transiting exoplanets revealed two distinct clusters in the mass-density space, one with hot Jupiters with a wide range of orbital periods and a narrow range of planet radii; and another one with a mixture of super-Earths, hot Neptunes and hot Jupiters, exhibiting a surprisingly narrow period distribution (3.7+/-0.8 days). These two clusters follow different distributions in the period-radius parameter plane. The branch of sub-Jupiter mass exoplanets is censored by the orbital period at large-radii: no planets with mass between 0.02-0.8 Mjup or with radius between 0.25-1.0 Rjup are known with Porb<2.5 days. This clustering is not predicted by current theories of planet formation and evolution and may indicate that sub-Jupiter mass planets on close orbits can totally evaporate near to the central stars.

2. Stellar astrophysics with the Kepler space telescope

2a HD181068 (a.k.a. Trinity): we have discovered a triply eclipsing compact hierarchical triple star in the Kepler field. The central star is a red giant, orbited by a close pair of two red dwarfs. From extensive ground-based observations (lucky imaging, spectroscopy, interferometry) we have

characterized the primary component, while light curve models were used to estimate the parameters of the dwarfs. The lack of solar-like oscillations in the red giant was a total surprise, indicating that some mechanism suppresses the amplitudes of the convectively driven oscillations. The discovery paper was published in the April 8th issue of the Science magazine (publ: 5).

2b Asteroseismology: we have intensively participated in several asteroseismic investigations by the Kepler Asteroseismic Science Consortium (within which PI Kiss and Co-I Szabó R. act as Working Group chairs). The highlights include the detection and the theoretical explanation of the chaotic pulsation in RR Lyrae, characterisation of the currently single Cepheid, and the asteroseismic characterization of red giant stars that are members of star clusters. Besides measuring the amplitude scaling of solar-like oscillations in giants as a function of physical parameters, we have been able to constrain cluster membership and even mass-loss processes from the fine analysis of the Kepler data. Publications: 10, 11, 14, 16, 17, 21.

3. Small bodies in our and other planetary systems

3a Exomoons: we have continued our investigations of how moons around exoplanets can be detected and characterised. Our latest study deals with a new method based on the local scatter of the light curves around the phases of the exoplanet transits. We have shown that a careful treatment of the data is needed to prevent the removal of the exomoon signal. Publications: 7 + a paper accepted by MNRAS.

3b Debris disks around nearby stars: we have studied the largest sample of F-type stars with circumstellar dust emission. These stars are hotter than the Sun and expected to have different planet formation mechanisms than the lower mass dwarfs. In several cases we found evidence of multiple ring structure in the debris disks that could be a potential indication of massive planets already clearing their immediate surrounding in the disk. In a related study we combined space data with ground-based optical surveys and high-resolution follow-up spectroscopy to find new members of nearby young moving groups (the beta Pic, Tuc-Hor and epsilon Cha groups). These stars often show debris disks, whose age is known from the group membership, so that they are important test objects of the theories of debris disk evolution. Publications: 9, 12.

3c Comet Hale-Bopp at 30 AU: using the 2.2m ESO MPG telescope in Chile, we have detected the nucleus (and possibly the faint coma) of comet Hale-Bopp way beyond Neptune's heliocentric distance. This was the farthest cometary nucleus ever detected and the observed characteristics are difficult to reconcile with the traditional understanding of matter production in comets. The data suggested two possible scenarios, one with a faint but unresolved coma and another one assuming a much higher albedo than expected. The latter could be due to a freshly frozen snow layer on the surface. To test this hypothesis, we have been granted six hours of observing time on one 8.2m unit of the Very Large Telescope of the European Southern Observatory in Chile. The observations will be obtained in late 2011. Publication: 19.

In total, we have published 21 refereed journal papers with the OTKA support explicitly acknowledged, with a cumulative impact factor of 171.7. We have been participants at several international conferences (IAU Symposia 276 and 282, the 4th KASC workshop) and visiting astronomers at various research centers (Harvard-Smithsonian Center for Astrophysics, University of Texas, Belgrade Astronomical Observatory).

In addition to the scientific research, we have been preparing the full modernisation of the 1m RCC telescope at the Piszkéstető Mountain Station. Because of the delay in transferring this grant's funds to the account of the Konkoly Observatory (the money was transferred in May 2011), we are late by several months compared to the early plans. We have already finished the preparations of the EU

tender in collaboration with the Apex-MM public procurement consultant company; the call will be published in early October 2011. We expect that several companies with expertise in telescope automatization will respond to the call and we will be able to make the selection before the end of the year. All the complementary funding from the Lendület project has already been made available by the Hungarian Academy of Sciences and we are confident in the success of the telescope modernisation.