The EXPLORE Project:
A Deep Search for Transiting Extra-Solar Planets *

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ABSTRACT

Searching for transits provides a very promising technique for finding close-in extra-solar planets. Transiting planets present the advantage of allowing one to determine physical properties such as mass and radius unambiguously. The EXPLORE (EXtra-solar PLanet Occultation REsearch) project is a transit search project carried out using wide-field CCD imaging cameras on 4-m class telescopes, and 8–10m class telescopes for radial velocity verification of the photometric candidates. We describe some of the considerations that go into the design of the EXPLORE transit search to maximize the discovery rate and minimize contaminating objects that mimic transiting planets. We show that high precision photometry (2 to 10 millimag) and high time sampling (few minutes) are crucial for sifting out contaminating signatures, such as grazing binaries. We have an efficient data reduction pipeline which allows us to completely reduce the data and search for transit candidates in less than one month after the imaging observations, allowing us to conduct same-semester radial velocity follow-up observations, reducing the phase uncertainty.

We have completed two searches using the 8k MOSAIC camera at the CTIO4m and the CFH12k camera at CFHT, with runs covering 11 and 16 nights, respectively. Using the 4400 images from the two fields, we obtained preliminary light curves for approximately 47,000 stars with better than $\sim 1\%$ photometric precision. A number of light curves with flat-bottomed eclipses consistent with being produced by transiting planets has been discovered. Preliminary results from follow-up spectroscopic observations using the VLT UVES spectrograph and the Keck HIRES spectrograph obtained for a number of the candidates are presented. Data from four of these can be interpreted consistently as possible planet candidates, although further data are still required for definitive confirmations.

Keywords: Extra-solar planets, transits, photometry, radial velocity

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1. INTRODUCTION

The discovery of giant extra-solar planets, such as 51 Peg b,\(^1\) with orbital periods of a few days and orbital radius < 0.1AU, was completely unexpected. Currently, 13 of these close-in extra-solar giant planets (CEGPs) are known, representing about 15% of the planets discovered by the radial velocity (RV) technique.\(^1\) The existence of close-in giant planets shows that planetary systems can be radically different from our own, and sparked much theoretical work on planet formation and migration scenarios to explain the proximity of giant planets to the parent stars (e.g., Refs. 2, 3, 4, and 5). This new class of planets also makes the method of finding planets via the transiting of their parent star very promising. In the situation of a Jupiter-sized planet transiting a solar-sized parent star, an eclipse with a flat-bottom light curve (due to the planet being completely superimposed on the parent star) of depth \(\sim 1\%\) is expected, an easily measurable effect with modern CCD photometry. The probability that a given planet will show transits is inversely proportional to its orbital distance; for CEGPs, this is typically \(\sim 10\%\). Moreover, the typical periods of a few days for CEGPs also makes monitoring for transits relatively easy.

Transiting planets offer a number of advantages over those discovered by the RV technique alone. They are currently the only ones for which a radius can be measured. Furthermore, absolute masses of transiting planets can be measured using the RV technique without the usual \(\sin i\) ambiguity. Transiting planets are also the most suitable for many kinds of follow-up studies, e.g., atmosphere transmission spectroscopy\(^6,7\), searches for moons and rings,\(^8\) and others.

Over the past few years, a large number of transit searches for extra-solar planets have been started (e.g., Refs. 9, 10, 11). However, currently only one unambiguous transiting planet is known, HD 209458b, which was discovered originally by the RV technique and later found to be a transiting planet\(^12,13\). In this paper we present preliminary results from the EXPLORE (EXtra-solar PLanet Occultation REsearch) project, which is the first 4m-class telescope transit search with 8-10m class spectroscopic radial velocity follow-up observations as an integral component of the search strategy. In Section 2 we outline some of the considerations that went into the design of the searches. Section 3 describes the two EXPLORE searches conducted so far. Preliminary results and possible transiting planet candidates are presented in Section 4. Finally, in Section 5 we provide a summary and briefly outline the future prospects for the EXPLORE project.

2. SOME CONSIDERATIONS FOR THE DESIGN OF TRANSIT SURVEYS

Detailed examinations of the various considerations that went into the design of the EXPLORE searches can be found in Refs. 14 and 15. Here, we present a brief summary.

2.1. Planet Detection Probability

An estimate of the fraction of monitored stars that have short-period transiting planets is instructive for designing a transit survey. The fraction of stars with transiting planets can be approximated by \(F_p \sim P_p P_g\), where \(P_p\) is the probability that a star has a planet within certain orbital radius, and \(P_g\) is the geometric probability that the planet will produce an eclipse. Using \(P_p \sim 0.007\) (Ref. 16) and \(P_g \sim 0.1\) for close-in planets of approximately Jupiter size, and assuming we can detect planets only around isolated stars (adopting a binary fraction of 1/2), we get \(F_p \sim 0.0035\), or one transiting CEGP in \(\sim 3000\) stars monitored with photometric precision of better than \(\sim 1\%\).

In practice, the fraction of stars with detected planetary transits will be much smaller (by a factor of 2 to 10) in a transit search, and it is dependent on a number of observational parameters, such as the window function of the observations, the photometric precision, and the time sampling. We discuss the effects of some of these parameters in the subsections below.

\(^{1}\)See, e.g., Extrasolar Planets Encyclopaedia, http://www.obspm.fr/encycl/catalog.html.
2.2. Constraining Planet Candidate Properties

An attractive aspect of transit searches is that with a high precision and high time-sampling light curve showing two or more eclipses with flat bottoms, a unique solution of the orbital parameters and companion radius can be derived by assuming a circular orbit and a mass-to-radius relation for the parent star. Specifically, the light curve needs to be of sufficient quality so that the time of ingress and egress, and the duration of the flat-bottomed part can be measured. The details concerning the derivations of the various parameters (specifically: the mass of the star, the radius of the star and of the companion, orbital distance, and orbit inclination) based on such a light curve can be found in Refs. 14 and 15. The unique solution provides a powerful tool to eliminate contaminating candidates (see Section 2.3). Thus, high-quality light curves are crucial for selecting the most robust planet candidates for mass determination follow-up observations, significantly increasing the efficiency of large telescope spectroscopy time.

2.3. Ruling out Contaminating Systems

The key signatures for a planet transit are: (1) they show a shallow eclipse (a few percent at the most), (2) the eclipses have a flat bottom (in a color where limb darkening is negligible), and (3) there is no secondary eclipse. However, there are at least three types of systems which can be confused with a transiting planetary system. Fortunately, high precision, high time-sampling light curves often can be used to rule out these contaminants, allowing one to produce a highly robust candidate list which will provide a high yield in radial velocity follow-up confirmation. We discuss these three cases briefly below. Examples of actual cases of these contaminants from our searches are presented in Section 4.

1. Grazing Eclipsing Binaries: At certain orbital inclinations, an eclipsing binary star system can produce the typical drop of $\sim 1\%$ expected for a transiting planet. For systems with two similar temperature stars, it would be impossible to discern a secondary eclipse. However, given a sufficiently high signal-to-noise ratio and high time-sample light curve, the shape of a grazing binary system can be differentiated from a planet transit, as the former would have V- or U-shape eclipses, whereas the latter would have a flat-bottomed eclipse. Distinguishing the two cases is also the easiest when limb-darkening is minimized, as in the case for light curves obtained in the redder pass bands.

2. Eclipsing Binary Systems with a Large Primary Star: A small star eclipsing a much larger star can produce a flat-bottomed light curve with $\sim 1\%$ depth, mimicking a typical expected signal from a transiting planet. Light curves with sufficient information to constrain a unique solution to the 5 parameters listed in Section 2.2 are usually able to distinguish such contaminants. For example, such a system often has a relatively long transit time. Spectral typing of the primary star will also allow one to differentiate such a system from a bona fide planetary transit.

3. Presence of a Contaminating Blended Star: A flat-bottomed and relatively deep eclipse from a companion star fully superimposed on its larger primary will appear shallower if there is a third, brighter star blended in the light curve. This type of contamination is probably the most difficult of the three to rule out based solely on the light curve. Typically such a blended system will have a relatively small ratio of flat-bottom to ingress/egress time, giving the appearance of a planet transiting within the narrow range of impact parameter near the stellar limb, which statistically is a relatively rare occurrence. In this situation, the solution to the system derived from the light curve may not be able to rule out such a contaminant definitively, and an additional constraint in the form of the radius of the primary star from spectral classification would be needed. If radial velocity data are available, such a system will typically appear as having a dominant zero velocity component (from the bright blended star) with a weaker component from the primary of the eclipsing system with the period and phase corresponding to the observed eclipses.

We note that a fourth, and potentially large, contaminating class is eclipsing late-M and brown dwarfs which have radii similar to gas giant planets. Such contaminants can only be ruled out by mass estimates using spectroscopy (see Section 2.5). However, most of these objects would be of interest in their own right.
Figure 1. Panel a: Examples of the visibility probability $P_{\text{vis}}$ of detecting transiting planets with different orbital periods. $P_{\text{vis}}$ is calculated with the requirement that two transits must be observed. Consecutive nights of 10.8 hours monitoring is assumed, with the triangles representing a 21-night run; bars, a 14-night run; and dotted line, a 7-night run, which is similar to the actual time coverage of the EXPLORE I search after accounting for weather. Panel b shows the integrated $P_{\text{vis}}$ as a function of the length of the run based on continuous monitoring of 10.8 hrs per night, for the cases of detecting two full eclipses (solid line) and one eclipse (dashed line). Panel c illustrates the efficiency per night, expressed in integrated $P_{\text{vis}}$ per night, as a function of the number of nights.

2.4. Maximizing the Visibility Probability

To effectively detect a transit candidate, especially with sufficient information to derive constraints on the characteristics of the system (viz Section 2.2), we need to detect at least two full eclipses from a system. For ground-based observations, using non-dedicated telescopes (e.g., 4m-class telescopes) with a limited period of time assigned, it is important to design searches which maximize the probability (which we term the visibility probability, $P_{\text{vis}}$) that the two-eclipse requirement is met. From general considerations and simulations, (for details, see Ref. 14), we find that using a continuous block of telescope time and following the monitored field for as long as possible each night provide the most efficient strategy. Figure 1a illustrates examples of $P_{\text{vis}}$ of detecting transits with different orbital periods for runs of different total lengths. The total efficiency of a run can be quantified approximately by $P_{\text{vis}}$ integrated over the periods of interest. For example, with 10.8 hrs of monitoring per night, the integrated $P_{\text{vis}}$ for systems with periods between 2 to 5 nights, ranges from $\sim 0.2$ for an 11-night run to $\sim 0.6$ for an 18-night run (Figure 1b). In terms of efficiency per night ($< P_{\text{vis}} >$ per night), the optimal efficiency peaks at about 20 nights, with a broad distribution between 16 to 30 nights, as shown in Figure 1c.

2.5. Radial Velocity Follow-up

Late-M dwarfs ($M \geq 80M_J$), brown dwarfs ($13M_J < M < 80M_J$), and gaseous giant planets ($M \leq 13M_J$) all have similar sizes due to a competition between Coulomb force and electron degeneracy effects.$^{17}$ Hence, a radius measurement from the transit light curve alone is insufficient for determining whether the transiting body is a true planet, even if it has a radius $\sim R_J$. Radial velocity measurements to estimate the mass are therefore
required to definitively determine the nature of the eclipsing object in most cases. Mass limits for candidates from deep transit searches using 4m-class telescopes can be routinely obtained using an echelle spectrograph on an 8m-class telescope for relatively faint stars ($I \leq 18$). For example, a solar mass star with an $80M_J$ M dwarf or a $13M_J$ brown dwarf companion with an orbital radius of 0.05 AU will show RV amplitudes of 10.1 km s$^{-1}$ and 1.6 km s$^{-1}$, respectively, which can be ruled out easily with RV measurements with accuracies of several hundred meters per second. Furthermore, if the period and phase of the orbit are known accurately, only a handful of RV points judiciously sampled are required to constrain the companion’s mass (see Ref. 14).

3. THE EXPLORE PROJECT

Two EXPLORE searches were conducted in 2001, one using the CTIO 4m telescope, and the other, the CFHT 3.6m. The combination of the wide-field capability of the mosaic CCD camera ($\sim 1/3$ square degrees) and the large telescope aperture makes observing high star density fields on the Galactic Plane an optimal strategy for maximizing the number of stars monitored. We use $I$ band images which minimize Galactic extinction and increase the number of late-type (small) stars monitored. Moreover, a red band decreases the effect of limb-darkening on the light curve shape of the eclipse, making a flat-bottomed eclipse more recognizable.

3.1. The EXPLORE I Search

The EXPLORE I search was carried out at the CTIO 4m, 30/May and 1–10/June/2001, for 11 nights. We used the Mosaic II CCD Imager, a 8096×8096 pixel CCD camera with a pixel scale of 0.27″/pixel, providing a field size of 36′ squared. We observed a single field near the Galactic Plane with $l = -27.8^\circ$ and $b = -2.7^\circ$. Images in $I$ band with a nominal integration time of 60 seconds were taken continuously. With a readout time of 102 seconds, the sampling rate is 2.7 minutes. The integration time was adjusted up or down based on seeing, cloud conditions, and sky brightness. We had clear weather for approximately 6 nights, with some additional data under poor conditions. Because of the loss of a significant number of nights to poor weather, the integrated $P_{vis}$ for the run is very low, only $\sim 7\%$. Figure 2 is a gray-scale image of a 60′ section of the field, showing the typical crowdedness of the field.
Figure 3. Example light curves from the EXPLORE I search. Each box in the panels represents one night of monitoring, with time expressed in relative Julian date. The night number is marked on the right hand side of the panels. Left panel: EXP1-c07s5157: The two 3% eclipses are likely due to a grazing binary system, as they have the typical V-shape expected for such systems. Right panel: EXP1-c01s52805: This object shows two eclipses of ~ 3% depth with clear flat bottoms. However, the relatively small ratio of the flat-bottom to ingress/egress time of indicates that the object is likely a blend of an eclipsing system plus a third brighter star.

A total of 1800 science frames were obtained from the EXPLORE I run. We developed a customized pipeline optimized for performing high-precision aperture photometry of faint stars in dense fields with well sampled point-spread functions. Since EXPLORE monitors relatively faint stars (comparable to sky brightness), a key feature in the photometry algorithm is to use small apertures (2′′ to 3′′) to minimize sky noise. In order to obtain accurate relative photometry using a small aperture, we use an iterative sinc-shift algorithm to resample every star in such a way that identical aperture, relative to the star profile, is used for integrating the flux. This is equivalent to centering the aperture on each star extremely accurately, a crucial step in accurate relative photometry. The data pipeline, from pre-processing of the images to the final production of the light curves, will be described in detail in Yee et al. (in preparation). Typically, our highly automated reduction procedures and pipelines allow us to produce preliminary light curves within one to two weeks of the end of an observing run, and a sample of possible transit candidates for spectroscopic follow-up within four weeks.

For the EXPLORE I field, we examined preliminary light curves of ~37,000 stars with photometry accuracy of better than 1%. Examples of light curves from the EXPLORE I search are shown in Figure 3 and discussed in Section 4. The planet candidates were searched using visual inspection, in which light curves with two or more shallow eclipses (< 3%) with discernible flat bottoms are chosen as candidates. While this is a relatively time consuming method, it is found, using a large number of simulated light curves which match the noise and time-sampling characteristics of the data, that visual inspection is able to pick out planetary transits at the 100% completeness level when the the depth of the eclipse is 2.5 to 3 times the rms scatter of the photometry of the light curve.18
3.2. The EXPLORE II Search

The EXPLORE II search was carried out at the CFHT using the CFH12K camera on 21/Dec/2001 to 05/Jan/2002, for a total of 16 nights. (The actual assignment was 14 nights, which was shared over 16 nights with another program.) We obtain good coverage under mostly excellent conditions for 14 nights. The CFH12K camera has a mosaic CCD detector of 12288×8096 pixels with a scale of 0.206″ per pixel, providing a field of view of ~ 42′ × 28′. We monitored a field on the Galactic Plane at l = 207° and b = 0.7°, using an I filter. The fiducial integration time was 90 seconds for the nominal 0.8″ seeing. With a readout time of 70 seconds, the sampling time is 2.7 minutes, similar to EXPLORE I. To avoid saturating the brighter stars, the integration time was adjusted throughout the run from 55 to 120 seconds, depending on seeing, which ranged from 0.5″ to above 1″. A total of ~ 2600 science frames were obtained during the run. The data were reduced and relative photometry light curves produced using the same pipeline as that for EXPLORE I. Because of the better seeing, longer integration time, and smaller pixel size, the average signal-to-noise (S/N) ratio is somewhat superior to that of the EXPLORE I data. However, because of the limitation on the accessible RA range due to the date of the observing run, the observable Galactic Plane region has considerably lower star density than that of the EXPLORE I search. To maximize the star density, the field chosen also contains an open star cluster, which occupies about two of the twelve chips of the CCD. Preliminary results from EXPLORE II are based on ~ 9500 stars with rms scatter of < 1%. An example of the distribution of rms scatter (averaged over a whole night) as a function of magnitude is shown in Figure 4. Examples of light curves from the EXPLORE II search are shown in Figure 5, and possible planet candidates are discussed in Section 4.

3.3. Spectroscopic Follow-up

At this point, we have conducted a limited amount of spectroscopic follow-up of the planet candidates from EXPLORE I and II, using the VLT 8.2m and Keck 10m telescopes, respectively. We obtained 19 hrs of VLT Director’s Discretionary time on September 2001 for radial velocity measurements of the EXPLORE I candidates. We followed-up our three most promising candidates using UVES. The observations were done in service mode, with data obtained over several nights, allowing for reasonable phase coverages for the candidates.

For EXPLORE II, we were assigned 5 half-nights on the Keck telescope with the HIRES spectrograph on February 2002, six weeks after the photometric survey. Prior the the Keck run, we also obtained classification spectra of our candidates on the APO ARC 3.5m, which allowed us to further refine our radial velocity follow-up sample. Due to poor weather, we obtained limited radial velocity data for two possible planet candidates and two additional eclipsing stars at Keck. Preliminary results of the RV follow-up observations are discussed in conjunction with the photometric light curves in the next section.

4. EXAMPLE LIGHT CURVES AND POSSIBLE PLANET CANDIDATES

We present a number of interesting light curves from the two EXPLORE searches, most with some velocity information. These light curves also provide some indications of the quality of the photometric data obtained by the EXPLORE project. We show first three non-planet transiting/eclipsing systems, which provide interesting illustrations of the possible contaminants discussed in Section 2.3. We then present two of the four possible planet candidates we have from our preliminary analysis of the two searches. These are promising candidates with at least some velocity information, but all require additional data to confirm their status definitively.

4.1. Non-Planet Transiting/Eclipsing Systems

(1) EXP1-c07s5157: This light curve from the EXPLORE I search shows two 3% eclipses with a period of ~ 3.2 days (Figure 3, left panel). The high time resolution and precision of the light curve indicate that this is likely a grazing binary with characteristic V-shape eclipses.

(2) EXP2-c04s5494: The left panel of Figure 5 shows a light curve from the EXPLORE II search with a very prominent flat-bottomed eclipse of 3% depth. The period, possibly 4.2 days, is not well determined, and is based on a second potential flat-bottomed eclipse partially observed during a night without full coverage. The flat bottom means that the transiting body is completely superimposed on the primary star. However, the long duration the eclipse suggests that this is a system with a small star eclipsing a considerably larger star. This star was
Figure 4. Typical photometric precision from the EXPLORE II search using the CFH12k camera. The rms in the photometry for each object is computed using measurements from the whole night.

not considered as a transiting planet candidate; however, because of its brightness, it was observed during the Keck spectroscopy run as a back-up object during poor observing conditions. Keck HIRES spectroscopy data show a single cross-correlation velocity peak which shifts significantly, confirming that this is an eclipsing binary system.

(3) EXP1-c01s52805: This star from the EXPLORE I search shows two well observed flat-bottomed eclipses with a depth of \( \sim 3\% \), and a period of 2.23 days (Figure 3, right panel). This was one of the three candidates for the VLT follow-up. However, the relatively small ratio of the flat-bottom to ingress/egress is a cause for concern. Classification spectra indicate that this is an early K-star. However, applying the uniqueness criterion to the light curve, the best fit indicates a parent stellar radius of an F star. Alternatively, this could be an eclipsing system of relatively late-type stars blended with a brighter star. VLT-UVES spectroscopy shows that there are in fact two cross-correlation velocity peaks, a strong stationary one, and a second broad, very weak one consistent with having a 2.23 day period and a \( \sim 60 \) km s\(^{-1}\) amplitude\(^{14} \) indicating a three-star blended system.

4.2. Possible Planet Candidates

(1) EXP2-c11s4809: This star from the EXPLORE II search shows a light curve with one full eclipse with a flat bottom and two partial eclipses (Figure 5, right panel). The eclipses have relatively short ingress/egress time, a period of 2.97 days and a depth of 1.7%. Based on the light curve, this is a promising candidate for RV follow-up. We were only able to obtain two spectroscopic observations at Keck for this possible planet candidate. The data show only one radial velocity peak (and hence it is unlikely a blend); however, both RV observations were obtained at almost the same orbital phase, and hence we are not able to set a mass limit for the transiting body.

(2) EXP1-c07s18161: The light curve of this relatively faint star (Figure 6, left panel) from the EXPLORE I search shows two rather noisy eclipses which are consistent with flat-bottomed transits with a period of 3.8 days and a depth of \( \sim 2.5\% \). This object was observed using the VLT-UVES spectrograph. The preliminary radial velocity points are shown in the right panel of Figure 6. The spectroscopic data are consistent with showing no radial velocity variations greater than \( \pm 200 \) km/s, providing a preliminary mass limit of \( \sim 2.5 \) \( M_J \), assuming that the eclipses observed in the noisy light curves are real. Additional photometric data are required to verify the reality of the eclipses for a definitive confirmation of this object as a transiting planet.
Figure 5. Examples of light curves from the EXPLORE II search carried-out using the CFHT CFH12k camera. The set up of the panel is the same as that of Figure 3. The night numbers increase from bottom to top, with the left column being nights 1 to 8, and the right column being nights 9 to 16. Left Panel: EXP2-c04s5494: A star with a very prominent flat-bottomed eclipse of \( \sim 3\% \) depth. The long transit time indicates that it is likely a small star crossing a large primary star. Keck spectroscopy indicates significant radial velocity changes, supporting such a conclusion. Right Panel: EXP2-c11s4809: A possible planet candidate showing a flat-bottomed eclipse of 1.7% depth. Currently, we have only very limited Keck spectroscopy data on this object and do not have sufficient multi-phase radial velocity data for the verification of the status of this candidate.

5. SUMMARY AND FUTURE PROSPECTS

Planet transit surveys have the promise of providing the next breakthrough in extra-solar planet detection and characterization. Transit searches can potentially yield a large number of close-in planets, and such a sample will allow extra-solar planets to be characterized in much greater detail than is possible with non-transiting planets discovered by RV techniques. However, up to now, the transit search technique has not been successful in producing new detections of planets. We examined the various aspects in the design of transit searches, focusing on optimizing searches which use telescopes with limited time availability (e.g., 4m-class national facilities) and the requirements for producing high-yield samples for spectroscopic follow-up RV observations using 8-10m class telescopes.

We showed that high-quality light curves with high precision photometry and frequent time sampling can provide sufficient information to winnow out most of the contaminating objects which may mimic transiting planets. We demonstrated that 8-10m class telescopes can provide useful mass limits for these possible planet candidates even for relatively faint stars of \( I \sim 18 \) mag. The advent of wide-field mosaic CCD cameras has made transit searches very attractive. We have conducted two searches using 4-m class telescopes as initial surveys. These two searches, with \( \sim 47,000 \) preliminary light curves examined, have produced four possible planet candidates which still require additional spectroscopic or photometry data for definitive confirmation.

New imaging capabilities at various observatories will further improve the efficiency of transit searches in the near future. One such example is the MegaCam at CFHT which will become operational in 2003. With a 1 square degree field, small pixels, excellent image quality and a very short readout time, it will be able to gather...
Figure 6. Left Panel: The light curve of EXP1-c07s18161 from the EXPLORE I search, a fainter star with a relatively low signal-to-noise ratio light curve. There are two possible flat-bottomed eclipses, though the one at night 6 is very noisy. Radial velocity data for this possible planet candidate were obtained using VLT-UVES. The left panel shows the preliminary velocity data superimposed on expected velocity models of an 80 $M_J$ M dwarf, a 13 $M_J$ brown dwarf, and a 2.5$M_J$ planet, with the uncertainty in the phase indicated. The two data points for each phase are based on the red and blue parts of the spectrum.

data for transit searches at a much greater rate than currently possible. For transit searches for fields at the Galactic Plane, the MegaCam can routinely monitor as many as 120,000 stars simultaneously with photometric precision of better than 1%. Currently there are a large number of on-going transit surveys, and large samples of transiting planets are expected to be discovered in the near future. The EXPLORE project is continuing with additional searches in 2002 and 2003 using NOAO 4m telescopes under their Survey Program. As MegaCam becomes available, we also plan to propose to conduct additional searches using CFHT.

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