OBSERVING REQUEST
Telescope Access Program, China

Year: 2017 **Term:** B **Proposal type:** short-term

Systematic study of Lithium, Rotation and Stellar Activity in Pleiades

P.I.: Bharat Kumar Yerra (NAOC; *bharat@nao.cas.cn*; +86-15910818644)
CoI(s): Xiang-Song Fang (NAOC), Gregory J. Herczberg (KIAA)

Abstract of Scientific Justification

Low mass stars carry footprints of complex phenomena during pre-main sequence evolution. Deep convective envelopes, strong magnetic fields, accretion history, and additional angular momentum in these stars affect their surface properties. Li gets easily destroyed at very low temperatures in stellar interiors, making it a sensitive probe to stellar mixing and a powerful age indicator. A large dispersion in Li abundance is observed among young stars in various open clusters, conflicts with the predictions of standard stellar models. The dispersion may be related to stellar rotation and activity. The Pleiades open cluster (125 Myr, d≈135 pc) is a testbed of thousands of co-eval stars to determine the effects of rotation on pre-main sequence evolution for stars over a wide mass range. We propose to use MMT with Hectochelle and Hectospec to conduct multi-object spectroscopy of Pleiades FGKM members. We will use low resolution spectra to quantify stellar activity, and high resolution spectra to derive Li abundance and projected rotational velocity ($v \sin i$). Results from our observations shall explain the Li dispersion among young stars and put constraints on stellar evolutionary models. While stellar activity and $v \sin i$ measurements will be combined with archival rotation rates to understand how rotation affects the convective dynamo.

Summary of observing runs requested for this project

								Scheduling		Sharing	
Run	Telescope	Cage	Instrument	PI	AO	Nights	Moon	Optimal	Acceptable	Poss.	Adv.
1	MMT	f/5	Hectospec,Hectochelle	*		3	bright	Oct–Dec	Sep–Dec	yes	yes
or:											
1a										no	no

Scheduling constraints and unusable dates *(up to 4 lines)*: None

no text past this line

A ⋆ appended to the proposal type indicates a continuation proposal; a ⋆ appended to the name of a proposer indicates the proposer is a (graduate) student; a proposer whose name is underlined is certified on the proposed telescope/instrument combination; if a ∗ appears within the PI or AO box in the observations summary table, the instrument is a PI instrument and/or Adaptive Optics are requested – signatures are required on the next page.

Target list (attach list if longer than 26 objects)

#	Object	RA	Dec	mag / color / type / redshift / comment / etc.
1	Pleaides	03:47:00.0	+24:07:00.0	$V = 10 - 19$, $Ks = 7 - 14$, FGKM type stars
2	List of targets are attached along with application			

If this program uses a PI instrument, attach the approval email from the PI to this proposal. yes

Graduate students *(provide the following information for* ***each*** *student named as PI or CoI on the cover page.)*

Student's Name	Advisor's Name	Thesis
		no

Scientific Justification *Describe the overall significance to astronomy and within the proposal's discipline. Limit text to one page, with a limit of two additional pages for figures, captions, and references.*

The evolution of low mass stars during pre-main sequence (PMS) is more complex due to their deep convective envelopes, strong magnetic fields, and accretion phenomenon. The complex structure and phonomena in these stars affect their surface properties and demands non-standard mixing processes. Lithium (Li) gets destroyed at very low temperatures ($\sim 2.5\times10^6$ K) via proton capture reactions (^{7}Li(p,α)^{4}He), which makes it an extraordinarily sensitive probe of structure and mixing process in stellar interiors. The time-dependence of Li depletion processes makes Li abundance a powerful age indicator for young stars, since it burns before stars reaches to main sequence (See Jeffries 2014). A large dispersion of Li abundance (e.g., a spread of $\sim$1.5 dex in A(Li)) is observed at a given effective temperature in many stellar populations e.g., for PMS and ZAMS stars in NGC 2264 (Bouvier et al. 2016), α Persei (Randich et al. 1998), Pleiades (Soderblom et al. 1993); and solar-like stars in old clusters (Sestito & Randich 2005) and field (Israelian et al. 2009).

The presence of a range of Li depletion at any given mass requires non-standard mixing processes, which may be explained by a dispersion in rotation rates (e.g., Soderblom 1995; Balachandran et al. 2011), i.e., rapid rotators show systematically high Li compared to their slowly rotating counterparts. In contrast, stellar models that include rotationally-induced mixing and dynamical instabilities predict more Li depletion in rapid rotators compare to slow rotators (e.g., Somers & Pinsonneault 2015a). To understand the above contradiction, the role of stellar magnetic activity, which is tightly correlated with rotation, in Li dispersion has been explored in both observational and theoretical perspectives (Cutispoto 2002; Mishenina et al. 2012). Non-standard stellar models, includes pre-MS Li depletion due to repeated accretion bursts and core-envelope decoupling, have been put forward to explain the intrinsic Li dispersion, but none of them could explain all dispersion patterns (Bouvier et al. 2016 and references therein). To explain Li dispersion in Pleiades, Somers & Pinsonneault (2015a, 2015b) introduced spot-induced radius inflation models with an assumption of large spot coverage on fast rotators. Our recent LAMOST survey of a subset of Pleiades stars revealed that large spot covering fractions are common and are related to rotation rate (Fang et al. 2016), supporting the models of Somers & Pinsonneault (2015a, 2015b). However, it is still not clear if the large spread of Li abundances observed in both clusters and field stars reflects a genuine dispersion, or the dispersion is due to a phenomenon that linked to stellar magnetic activity or main-sequence/pre-main sequence depletion. Whether a tight correlation exists between Li abundance and stellar mass is still an open question.

Since the Pleiades open cluster is nearby ($\sim$135 pc; Melis et al. 2014), rich ($>$ 2000 members; e.g., Bouy et al. 2015), and has solar metallicity ($[Fe/H] = 0.03$; Soderblom et al. 2009), it has become a benchmark cluster and the anchor of astrophysical problems associated with stellar structure and evolution, including those related to rotation (e.g., Matt et al. 2012; Stauffer et al. 2016). Dedicated photometric surveys increased the measurements of rotation periods for about 1000 members of Pleiades (e.g., Rebull et al. 2016). Spot coverages for more than 200 members are measured in our study (Fang et al. 2016), though the measurement errors are large for late M-type stars with low quality spectra. However, only a small fraction of Pleiades FGK members have Li measurements ($\sim$100 stars; Soderblom et al. 1993), in which most of them are hotter ($>$4500) stars. We made measurements of Li abundance, using Li to Ca ratio, from LAMOST spectra of members in Pleiades and other open clusters (Figure 1), and they show existence of Li dispersion, a good agreement with Sestito & Randich (2005).

In this study, we plan to derive Li abundance from high resolution spectra and extend the measurements for stellar activity to lower mass range for large sample of Pleiades FGKM members (See Figure 2) focusing to improve measurements of Li dispersion versus mass, and test the connection with magnetic activity and rotation, that will provide clues to stellar mixing process and put strong constraints on stellar evolution models. In addition, Li-depletion pattern of very cool Pleiades members in our sample would provide good constraints on Li-depletion-boundary (LDB) based age for this young open cluster, which is still in debate (e.g., Dahm 2015). The spot coverage measurements along with rotation of our sample would shed new light on how the generation of a magnetic dynamo affects convective efficiency and pre-main sequence stellar evolution (e.g. Baraffe et al. 2015). Projected rotational velocity along with rotation periods of large sample in wide range of mass allow to investigate the radius inflation problem (Somers & Stassun 2017), which could be likely produced by magnetic suppression of convection and/or extensive cool starspots.

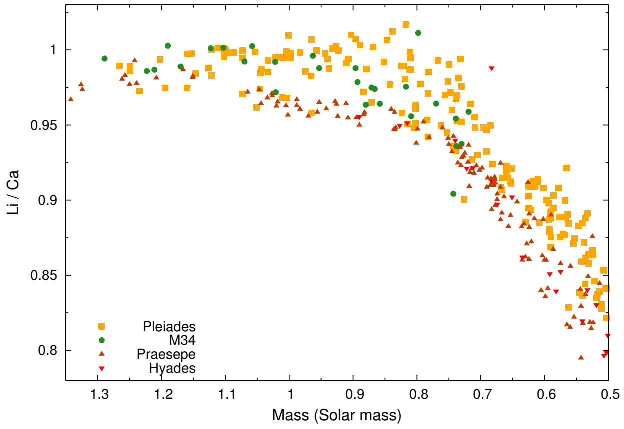

Figure 1: Qualitative measurements of Li abundance, based on LAMOST spectra, for members in various open clusters. Note the existence of Li dispersion with mass.

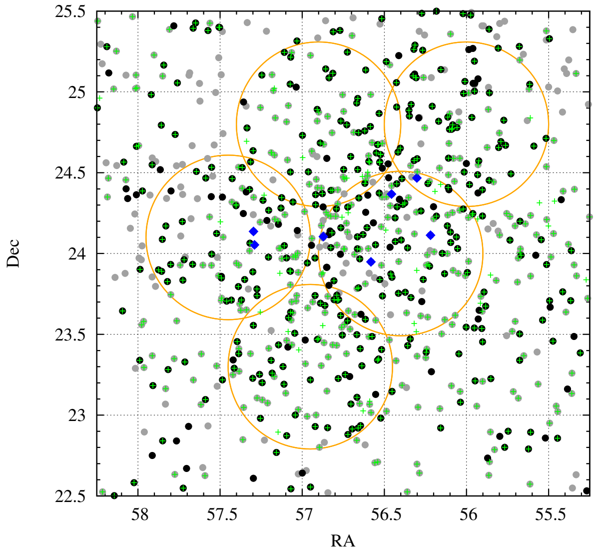

Figure 2: Selected fields (orange circles) in Pleiades for observations. Grey and black circles represents members with V∼15-19 and V<15, respectively. Stars with rotation periods are marked in green symbols. Blue symbols are the seven sisters of Pleaides.

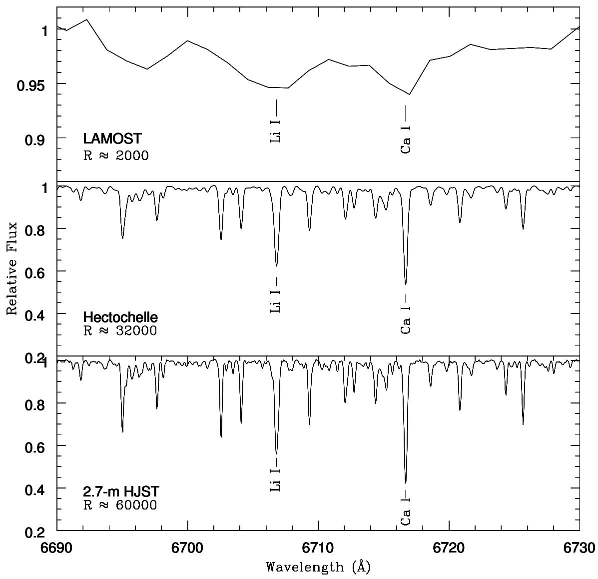

Figure 3: Spectra in Li region of same star is shown for different resolution. Hectospec spectra will look similar to LAMOST (top) spectra. High resolution spectra taken from 2.7-m Harlan J. Smith telescope at McDonald observatory (bottom) is used to degrade upto expected resolution from Hectochelle (middle). Li I at λ 6708 Å and Ca I at λ 6717Å are marked for reference.

References

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Experimental Design *Describe your overall observational program design. How will these observations contribute toward the accomplishment of the goals outlined in the science justification? Include information such as why the specific targets were selected, the sample size, the analysis plan, instrument choice, etc. Also briefly explain what expertise or effort each team member will contribute to the project. Describe any necessary non-standard calibrations (**up to one page**).*

Our goal is to quantify the empirical relationships of stellar activity, Li abundance, and projected rotational velocity ($v \sin i$). Stellar activity will be quantified by measuring cool star-spot coverages and temperatures on stellar surface, which is possible through spectral modeling of observed low resolution spectra with inactive templates via many indices of molecular bands (e.g. TiO2, TiO5, CaOH). The atomic spectral lines (e.g. Li; See Figure 3) in low-resolution spectra are blended with many nearby lines that will not allow to derive accurate abundances. Li abundance and projected rotational velocity ($v \sin i$) will be obtained from spectral synthesis of observed spectral lines, which is possible through spectra with high resolution.

Target Selection We selected Pleiades whose tidal radius is around 5 degree, and its known members are over 2000 till the date. Catalogs of dedicated photometric surveys provide rotational periods for about 1000 members. Sample stars for this study are selected based on following criteria: 1. Cover a large spectral range late-F to late-M that implies surface temperature between 6500 to 3000 K; 2. Cover many sample with available rotational periods; 3. Cover many lower mass (V>15) targets for low-resolution mode to extend our LAMOST study (See Figure 2); 4. Cover many massive (V<15) targets in common with LAMOST study (Figure 2) for high-resolution mode to calibrate Li abundance.

Observational strategy The study is of two fold that requires two observational set-ups in low and high-resolution mode. Hectospec is a suitable instrument that could provide low resolution spectra of more than 200 stars in one degree field of sky and covers entire optical wavelengths. Spot coverage indicators are TiO and CaOH bands that occupy between 6000-8000 Å, which is possible through Hectospec. Li abundance will be obtained from Li line at 6707 Å and it is possible to derive from spectra with R∼32,000 (See Figure 3), which is possible through high resolution spectra from Hectochelle which could provide a single order spectra for more than 200 stars in one degree field of sky. Our sample contains more than 500 stars that covers 5 different fields with each field size of 1 degree on sky. Using Hectospec and Hectochelle, which covers 1 degree field on sky, we require 5 pointings in each set-up to cover entire sample. Due to the brightness (V) of stars in each field varies between 10 to 19, we will obtain both short and long exposures in the same field.

Data Plan B.K.Y has good experience in high resolution spectroscopic observations, data reduction, and analysis. X.F. has good experience in low resolution spectroscopic observations, data reduction, and analysis. G.J.H. has extensive experience in spectroscopic observations and handling the data. The raw spectra from Hectospec and Hectochelle will be reduced using the HSRED reduction pipeline that is publically available package and/or using standard tasks available with $IRAF$. X.F. will analyse the spot coverages and Li from Hectospec spectra. B.K.Y will analyse Li abundance and projected rotational velocity from Hectochelle spectra. Li abundance from high resolution spectra will be used to make calibration relations to derive Li abundance from low resolution spectra.

Technical Justification *Justify the instrument configuration, the required signal-to-noise, exposure times. All requests for dark or gray time must include a detailed justification for the requested lunar phase. Specify the total time needed, and (if applicable) the minimum requested time (**up to one page**).*

We propose to conduct multi-object spectroscopy in low and high resolution mode to measure spot coverages, rotational velocity, and Li abundances in large sample of Pleiades members. We chose 600 line grating for Hectospec that provides spectral coverage of nearly 3500 Å centered at 6800 Å in R≈2000. At proposed wavelength range, we can measure spot coverage using TiO and CaOH bands that occupy between 6000 and 8000 Å. We will use new OB24 filter for Hectochelle that provides wavelength coverage of nearly 150 Å centered at 6770 Å. At the proposed wavelength, we measure Li abundance from Li resonance doublet at 6707 Å and projected rotational velocity is measured from nearby Fe lines at 6703 Å and 6705 Å and Ca line at 6717 Å (See Figure 3).

Exposure times The required SNR to determine spot coverage parameters is above 50. We used the exposure time calculator for Hectospec observations. Our sample covers late-K and cooler stars with brightness range between 15 and 19 in V band. We estimated for V=19 at 6800 Å SNR>50 can be achieved at 2400s with sky conditions of $0\farcs8$ seeing and at 1.2 airmass. With 40 min exposure on one field and 300s readout, we estimate each pointing will take 45 min. The exposure time calculator is not available for Hectochelle, but according to manual, we found For V=15 mag around 6300 Å SNR=30 could be achieved at 2700s*4 with sky conditions of $0\farcs8$ seeing and at 1.2 airmass. Li line falls around 6700 Å and late type stars in our sample are expected to have peak counts in required wavelength. Hence, we will choose 3.7 hrs exposure on one field to achieve SNR>50, and estimated is each pointing will take 4 hrs including 1200s readout.

Total Request With each pointing taking 4hrs, and 5 pointings, we estimate that observations with Hectochelle will take 20 hours of on-sky time. 45 min of each pointing and 5 pointings are in total, the estimated time to complete the observations with Hectospec is 4 hours of on-sky time. We estimate that total program will take 24 hours of on-sky time. This will be spread out over four to five different nights due to the visibility of the Pleiades and the queue-like observational strategy used by Hecto team, and is optimal for scheduling with other programs. Bright time during the months of Oct–Dec are optimal because Pleiades is available with airmass 1.2 as viewed from Steward.

TAP Usage and Context *The TAC needs to understand the scope of this project — (1) How many total TAP nights have already been allocated for this project (if any), how many are you requesting this semester, including any CFHT time from a linked proposal, and if more time will be necessary in future semesters, how many nights will you need to complete the project (best guess)?; (2) If a observing for this project comes from, or is being requested from, resources outside TAP, tell us about that observing, and how the TAP part fits in. (3) List any time from partner institutions, going toward (or being requested for) this project from TAP partners (e.g., Arizona, UC, Caltech, CFH, etc.), and who is the lead investigator on that time; (3) If you are collaborating with people who have access to other telescopes, especially if you are part of a large collaboration, tell us who is leading the project, and how TAP time and your participation fit in. 4) Please explain any ways in which this program would help fulfill the goals of the Telescope Access Program.* ***(up to one page)***

We are requesting 3 nights from TAP on the MMT 6.5 telescope in 2017B. This will be sufficient to complete the project. This is the first TAP application for this project and currently no time is allocted on non-TAP telescopes for this project. The collaborators on this team are from different institutes within China, and all the data reduction and analysis will also be done here.

Previous Use of TAP Facilities *List **all** allocations of telescope time for the present project and allocations for other projects on facilities available through TAP during the past 2 years, together with the amount of time awarded (e.g. 2 nights, 6 hours), the percentage of this that was useful (e.g. 80), and text describing the current status of any data obtained. Cite publications that were based (to a significant extent) on data obtained at TAP facilities. Mark those allocations related to the present proposal (i.e, precede text with `\related` command).* ***(up to one page)***

⋆

LaTeX 2_ε TAP Observing Proposal class, 'tapprop' v1.1 (2015 Mar 15 [E.Peng]).

Subject:	Fwd: No response yet from Andrew Szentgyorgyi
From:	Gregory Herczeg Mar 22, 2017 6:51:12 AM
To:	Bharat Kumar Yerra, 房祥松

---------- Forwarded message ----------
From: Szentgyorgyi, Andrew <aszentgyorgyi@cfa.harvard.edu>
Date: Wed, Mar 22, 2017 at 12:08 AM
Subject: Re: No response yet from Andrew Szentgyorgyi
To: Gregory Herczeg <gherczeg1@gmail.com>

Dear Gregory and Bharat:

I thought I had responded. If not, perhaps this is sufficient:

To Whom It May Concern:

I, Andrew Szentgyorgyi, endorse and support Dr. Yerra's proposal to measure lithium abundances in the Pleiades using the Hectochelle instrument on the MMT. I am the principle investigator of the Hectochelle instrument.

Best,
Andrew Szentgyorgyi

On Mon, Mar 20, 2017 at 9:15 PM, Gregory Herczeg <gherczeg1@gmail.com> wrote:

> Dear Andrew,
>
> I am working with Bharat Kumar and Xiang-song Fang on an MMT/Hectochelle proposal, to be submitted through NAOC in China. They hadn't heard back yet and would like approval before the deadline (22 March in China).
>
> Please let us know if you'd like any additional information about the proposal.
>
> Thanks!
>
> -greg
>
> -----Original Messages-----
> From: "Bharat Kumar Yerra" <bharat@bao.ac.cn>
> Sent Time: Sunday, March 19, 2017
> To: aszentgyorgyi <aszentgyorgyi@cfa.harvard.edu>
> Cc: xsfang <xsfang@bao.ac.cn>
> Subject: Re: Your approval for using Hectochelle
>
> Dear Sir,
>
> We are applying for MMT observing time through Chinese Telescope Access Program and the deadline is March 22.
> We need to attach your response along with the application during proposal submission. Hence, we request you to kindly
> permit us to use Hectochelle instrument through your positive response.
>
> Thanking you.
>
> Sincerely,
> Bharat and Fang
>
>> -----Original Messages-----
>> From: "Bharat Kumar Yerra" <bharat@bao.ac.cn>
>> Sent Time: Thursday, March 16, 2017

> To: aszentgyorgyi@cfa.harvard.edu
> Cc: xsfang <xsfang@bao.ac.cn>
> Subject: Your approval for using Hectochelle
>
> Dear Prof. Szentgyorgyi
>
> I, Bharat Kumar, am an astronomer from National Astronomical Observatories, Chinese Academy of Sciences, Beijing. We are preparing an observing proposal for MMT time to observe Pleiades members (>300) to measure Li abundance from good quality high resolution spectra and study correlation with rotation and magnetic activity. Also, derived Li abundances are used to calibrate relations obtained from low resolution spectra and derive Li abundances for sample of other clusters. Results shall make a clear relation between these three important parameters and put constraints on Li dispersion and associated stellar mixing process. We found Hectochelle is a suitable instrument to obtain spectra of large number of member stars. Hence, we are requesting for your approval to use the instrument if telescope time is approved.
>
> Thanking you.
>
> Sincerely,
> Bharat.
>
> Bharat Kumar Yerra
> Postdoctoral Fellow
> NAOC, Beijing
> PR China

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Andrew Szentgyorgyi
Solar, Stellar and Planetary Sciences Division
M/S 15 Harvard-Smithsonian Center for Astrophysics
60 Garden St.
Cambridge, MA 02138
saint@cfa.harvard.edu / ahszentgyorgyi@gmail.com
617-495-7397

Subject:	Re: Request for using Hectospec
From:	Fabricant, Daniel Mar 20, 2017 2:45:30 PM
To:	Bharat Kumar Yerra

Dear Dr. Yerra,

You have my permission to use Hectospec for this proposal.

Best,
Daniel Fabricant

On Sun, Mar 19, 2017 at 9:51 AM, Bharat Kumar Yerra <bharat@bao.ac.cn> wrote:

> Dear Sir,
>
> We are applying for MMT observing time through Chinese Telescope Access Program and the deadline is March 22.
> We need to attach your response along with the application during proposal submission. Hence, we request you to kindly
> permit us to use Hectospec instrument through your positive response.
>
> Thanking you.
>
> Sincerely,
> Bharat and Fang
>
> > -----Original Messages-----
> > From: "Bharat Kumar Yerra" <bharat@bao.ac.cn>
> > Sent Time: Thursday, March 16, 2017
> > To: dfabricant@cfa.harvard.edu
> > Cc: xsfang <xsfang@bao.ac.cn>
> > Subject: Request for using Hectospec
> >
> > Dear Prof. Fabricant,
> >
> > I, Bharat Kumar, am an astronomer from National Astronomical Observatories, Chinese Academy of Sciences, Beijing.
> > We are preparing an observing proposal for MMT time to observe Pleiades members (>500) to measure spot coverage from low resolution spectra and check correlation with rotation and Li abundance. Results shall make a clear relation between these three important parameters and put constraints on stellar mixing process.
> > We found Hectospec is a suitable instrument to obtain spectra of large number of member stars.
> > Hence, we are requesting for your approval to use the instrument if telescope time is approved.
> >
> > Thanking you.
> >
> > Sincerely,
> > Bharat.
> >
> > Postdoctoral Fellow
> > NAOC, Beijing
> > PR China

------ Pleiades_sample_MMT ------

Star Name	RA (J2000)	Dec (J2000)	Ks
SI2M-5	56.29098	24.07576	13.86
SI2M-10	56.40739	23.73057	13.81
SI2M-16	56.45598	23.95163	13.83
SI2M-26	56.52526	23.972	13.93
SI2M-27	56.57735	23.98407	13.86
HD 23170	55.961143	25.268934	8.214
Melotte 22 25	55.729626	24.493065	8.263
Melotte 22 34	55.76223	24.669737	9.727
Melotte 22 97	55.860924	24.994333	9.795
Melotte 22 120	55.883141	23.674074	9.103
Melotte 22 129	55.893372	23.761917	9.37
Melotte 22 133	55.903843	24.393944	10.636
Melotte 22 134	55.902607	24.2323	10.126
Melotte 22 153	55.93	25.080687	7.168
Melotte 22 157	55.923031	23.649132	7.028
Melotte 22 158	55.93021	24.37455	7.561
Melotte 22 164	55.928608	23.594801	8.233
Melotte 22 173	55.951721	25.190042	8.827
Melotte 22 174	55.951378	25.004387	9.374
Melotte 22 191	55.967266	24.841591	10.646
Melotte 22 193	55.961273	24.247465	9.344
Melotte 22 212	55.982037	24.42639	10.645
Melotte 22 232	56.001106	24.55695	7.583
Melotte 22 233	55.995003	23.88273	8.308
Melotte 22 248	56.002472	23.543961	9.199
Melotte 22 250	56.017681	24.989822	9.061
Melotte 22 253	56.014748	24.504206	8.953
Melotte 22 263	56.020168	24.275501	9.386
Melotte 22 293	56.05798	24.779388	9.062
Melotte 22 298	56.053902	24.031099	8.728
Melotte 22 303	56.061119	24.101816	8.314
Melotte 22 314	56.083687	24.796156	8.9
Melotte 22 320	56.085445	24.772854	8.869
Melotte 22 324	56.09127	24.768408	10.07
Melotte 22 335	56.096096	24.068304	10.218
Melotte 22 338	56.09811	24.132639	7.769
Melotte 22 344	56.107113	24.394674	7.47
Melotte 22 345	56.109486	24.589705	9.266
Melotte 22 347	56.113724	24.843962	10.015
Melotte 22 357	56.116707	24.171558	10.025
Melotte 22 370	56.133255	23.875212	10.452
Melotte 22 380	56.155899	25.137793	10.239
Melotte 22 390	56.147549	24.001354	10.654
Melotte 22 405	56.1698	24.818542	8.513
Melotte 22 430	56.18325	24.231215	9.469
Melotte 22 451	56.209042	24.911133	10.341
Melotte 22 476	56.224304	23.921267	8.816
Melotte 22 489	56.234989	24.432623	8.866

Melotte 22 514	56.266689	25.257841	9.041
Melotte 22 522	56.263603	23.839439	9.73
Melotte 22 530	56.272011	23.702707	8
Melotte 22 531	56.277229	24.263523	7.738
Melotte 22 554	56.299938	24.586178	10.556
Melotte 22 559	56.306339	25.087755	10.22
Melotte 22 566	56.309212	25.088799	10.782
Melotte 22 571	56.313946	25.289476	9.228
Melotte 22 590	56.325584	25.099545	10.651
Melotte 22 605	56.336918	24.922075	7.838
Melotte 22 624	56.347889	24.8508	11.037
Melotte 22 625	56.338284	23.727499	9.402
Melotte 22 627	56.350533	24.885977	8.419
Melotte 22 636	56.34248	23.471731	9.848
Melotte 22 652	56.358902	24.035139	7.459
Melotte 22 659	56.358242	23.430206	9.704
Melotte 22 673	56.375916	24.312651	11.129
Melotte 22 676	56.373203	23.760529	10.341
Melotte 22 686	56.387222	24.303242	10.22
Melotte 22 697	56.393559	24.463299	7.67
Melotte 22 708	56.397484	24.08321	8.562
Melotte 22 727	56.41737	24.627245	8.294
Melotte 22 738	56.4142	23.754284	9.007
Melotte 22 739	56.42548	24.905998	7.939
Melotte 22 740	56.426872	25.057091	10.504
Melotte 22 745	56.422436	24.288599	8.04
Melotte 22 746	56.424374	24.431513	9.398
Melotte 22 761	56.43504	24.220335	8.753
Melotte 22 762	56.43364	24.074102	10.638
Melotte 22 793	56.453922	23.852869	10.701
Melotte 22 799	56.460346	23.873947	10.17
Melotte 22 804	56.465149	24.038902	7.332
Melotte 22 813	56.474026	24.469128	10.569
Melotte 22 870	56.511482	23.737392	9.257
Melotte 22 879	56.527061	24.567419	10.113
Melotte 22 882	56.517178	23.405537	9.836
Melotte 22 883	56.528744	24.562807	10.286
Melotte 22 885	56.53236	24.866802	9.357
Melotte 22 890	56.531269	24.37438	10.86
Melotte 22 906	56.541225	24.673626	10.593
Melotte 22 915	56.534836	23.347523	10.403
Melotte 22 916	56.548939	24.622314	9.545
Melotte 22 923	56.541874	23.340015	8.659
Melotte 22 930	56.553612	24.054377	10.6
Melotte 22 948	56.552853	23.128571	7.285
Melotte 22 956	56.566689	24.189842	7.115
Melotte 22 974	56.585312	24.78548	10.538
Melotte 22 975	56.574959	23.486664	8.504
Melotte 22 996	56.594479	24.570177	8.923

Melotte 22 1015	56.613968	25.135563	8.993
Melotte 22 1028	56.61367	24.255032	7.125
Melotte 22 1029	56.619274	24.758995	10.647
Melotte 22 1032	56.618378	24.433918	9.159
Melotte 22 1039	56.615738	23.592699	9.821
Melotte 22 1061	56.62991	24.11735	10.338
Melotte 22 1081	56.636982	23.305323	10.782
Melotte 22 1084	56.642521	23.62401	7.067
Melotte 22 1094	56.649624	23.967031	10.656
Melotte 22 1095	56.657391	24.747698	9.669
Melotte 22 1100	56.655285	24.343527	9.4
Melotte 22 1101	56.661587	24.959629	8.763
Melotte 22 1103	56.647205	23.411737	10.723
Melotte 22 1110	56.662018	24.520338	10.274
Melotte 22 1114	56.667778	24.93103	10.384
Melotte 22 1117	56.656994	23.787771	8.527
Melotte 22 1122	56.663857	24.103243	8.191
Melotte 22 1124	56.664104	24.029688	9.859
Melotte 22 1132	56.659985	22.919804	8.153
Melotte 22 1136	56.667671	23.497789	9.34
Melotte 22 1139	56.666656	23.110371	8.243
Melotte 22 1173	56.705051	24.600019	10.996
Melotte 22 1182	56.696087	22.914593	8.928
Melotte 22 1200	56.710571	23.239195	8.546
Melotte 22 1207	56.728828	24.796349	8.977
Melotte 22 1215	56.723911	23.583599	8.996
Melotte 22 1220	56.72192	22.880943	9.719
Melotte 22 1266	56.764782	24.819933	7.334
Melotte 22 1275	56.755909	23.494984	9.534
Melotte 22 1280	56.764931	24.15971	10.717
Melotte 22 1284	56.767551	23.995174	7.642
Melotte 22 1286	56.765728	23.616325	10.596
Melotte 22 1298	56.778252	23.71517	9.839
Melotte 22 1305	56.780609	23.226339	10.397
Melotte 22 1306	56.78558	23.710819	9.902
Melotte 22 1309	56.791893	24.276672	8.282
Melotte 22 1321	56.789314	23.742186	10.656
Melotte 22 1332	56.806374	23.71431	10.009
Melotte 22 1338	56.819008	24.128347	7.486
Melotte 22 1348	56.825268	24.390772	9.719
Melotte 22 1355	56.825562	24.036524	10.191
Melotte 22 1362	56.830624	24.139126	7.639
Melotte 22 1384	56.85022	24.588472	7.003
Melotte 22 1397	56.851677	23.914713	7.137
Melotte 22 1407	56.845417	22.922121	7.52
Melotte 22 1425	56.861771	23.678368	7.343
Melotte 22 1454	56.89032	24.684223	10.128
Melotte 22 1485	56.908653	24.891832	10.608
Melotte 22 1512	56.908363	23.468056	10.325

Melotte 22 1514	56.918537	24.364594	8.953
Melotte 22 1516	56.918228	24.301937	10.342
Melotte 22 1531	56.922657	23.971945	10.312
Melotte 22 1532	56.921581	23.740294	10.57
Melotte 22 1553	56.920734	22.930014	9.356
Melotte 22 1593	56.950462	23.21814	9.324
Melotte 22 1613	56.968838	23.941282	8.574
Melotte 22 1653	56.998894	24.731342	10.159
Melotte 22 1726	57.029949	24.142099	7.939
Melotte 22 1756	57.045776	23.507023	10.686
Melotte 22 1762	57.05645	24.318428	7.352
Melotte 22 1766	57.070267	25.21517	7.862
Melotte 22 1776	57.073719	25.047886	9.158
Melotte 22 1785	57.072041	24.504429	10.688
Melotte 22 1794	57.071342	23.890385	8.891
Melotte 22 1797	57.070457	23.636806	8.736
Melotte 22 1827	57.094868	23.972546	10.511
Melotte 22 1856	57.109024	24.048445	8.663
Melotte 22 1883	57.116787	23.300774	9.836
Melotte 22 1912	57.145004	24.181202	7.769
Melotte 22 1924	57.143806	23.434818	8.868
Melotte 22 1993	57.18288	23.259859	7.631
Melotte 22 2016	57.189312	23.338873	10.375
Melotte 22 2027	57.203949	24.267435	8.81
Melotte 22 2034	57.205509	23.97732	9.992
Melotte 22 2082	57.245682	25.103958	10.571
Melotte 22 2106	57.24369	23.201229	9.377
Melotte 22 2126	57.259705	23.252468	9.657
Melotte 22 2147	57.275452	23.781273	8.603
Melotte 22 2172	57.298859	24.636606	8.949
Melotte 22 2193	57.296989	23.555243	10.575
Melotte 22 2195	57.300808	23.886839	7.576
Melotte 22 2208	57.314083	24.567284	10.494
Melotte 22 2209	57.301277	23.228354	10.721
Melotte 22 2220	57.319969	24.396139	7.257
Melotte 22 2244	57.335793	24.77667	9.925
Melotte 22 2278	57.357094	24.93762	8.805
Melotte 22 2284	57.350216	23.839287	9.378
Melotte 22 2289	57.358269	24.247681	7.515
Melotte 22 2311	57.369747	23.712238	9.428
Melotte 22 2341	57.388004	23.795427	9.214
Melotte 22 2345	57.386341	23.380413	8.036
Melotte 22 2366	57.402245	24.296135	9.55
Melotte 22 2368	57.395473	23.454689	10.42
Melotte 22 2406	57.414158	23.290129	9.256
Melotte 22 2407	57.426128	24.46306	9.783
Melotte 22 2415	57.420506	23.341612	7.648
Melotte 22 2462	57.459827	23.705631	9.595
Melotte 22 2488	57.485859	24.34907	7.35

Melotte 22 2506	57.485363	23.218641	8.796
Melotte 22 2548	57.521084	24.123985	10.586
Melotte 22 2588	57.551674	24.532957	10.271
Melotte 22 2601	57.553776	24.351862	10.627
Melotte 22 2602	57.551086	23.995897	10.845
Melotte 22 2644	57.587078	24.466755	9.307
Melotte 22 2741	57.644051	24.507822	10.08
Melotte 22 2786	57.666985	23.933065	8.853
Melotte 22 2880	57.729527	24.197466	9.629
Melotte 22 2881	57.726337	23.834896	9.054
Melotte 22 2966	57.800304	23.932636	10.903
Melotte 22 2984	57.820232	23.826605	9.957
Melotte 22 3019	57.851673	24.087425	10.278
Melotte 22 3031	57.863419	24.518692	7.877
Melotte 22 3063	57.874737	23.899223	10.363
Melotte 22 3163	57.972446	24.387018	9.883
Melotte 22 3179	57.986889	23.901966	8.632
Melotte 22 BPL50	55.755241	24.247917	13.306
Melotte 22 BPL55	55.807945	24.13895	12.975
Melotte 22 BPL77	56.455654	24.418707	11.803
Melotte 22 BPL82	56.479099	24.223949	11.845
Melotte 22 BPL85	56.51231	24.682182	13.139
Melotte 22 BPL87	56.516426	24.385818	13.501
Melotte 22 BPL88	56.518993	24.165571	13.184
Melotte 22 BPL94	56.570175	24.440922	12.769
Melotte 22 BPL99	56.595936	24.605053	12.716
Melotte 22 SK204	58.009426	24.363386	11.372
Melotte 22 SK236	57.825802	24.340622	13.067
Melotte 22 SK287	57.517666	23.17907	12.335
Melotte 22 SK293	57.493065	23.709436	11.567
Melotte 22 SK315	57.360939	22.848576	12.511
Melotte 22 SK316	57.341343	24.912077	12.754
Melotte 22 SK368	57.095013	24.814903	12.02
Melotte 22 SK394	56.970276	22.992798	12.16
Melotte 22 SK398	56.949383	25.226257	12.088
Melotte 22 SK409	56.908524	24.819742	11.697
Melotte 22 SK417	56.867142	23.448219	11.901
Melotte 22 SK428	56.836803	25.086767	11.136
Melotte 22 SK432	56.813702	25.115416	11.485
Melotte 22 SK465	56.650269	23.071491	12.054
Melotte 22 SK488	56.523464	24.612358	11.442
Melotte 22 SK497	56.488621	25.18693	11.448
Melotte 22 SK520	56.365524	23.170357	11.691
Melotte 22 SK526	56.315907	25.11026	11.028
Melotte 22 SK564	56.132133	23.590618	12.2
Melotte 22 SK586	56.039993	24.589565	12.056
Melotte 22 SK596	55.986195	25.262264	11.32
Melotte 22 SK609	55.95985	25.053202	10.832
Melotte 22 SK630	55.904587	23.642277	11.869

Melotte 22 SK638	55.862373	24.452726	11.419
Melotte 22 SK646	55.815552	25.341557	11.504
Melotte 22 SK676	55.619373	25.016804	11.672
Melotte 22 SK701	55.513741	24.537067	11.632
Melotte 22 SK702	55.50005	25.0298	12.165
Melotte 22 BPL 68	56.006973	23.862829	11.993
Melotte 22 BPL101	56.600491	24.503605	13.836
Melotte 22 BPL107	56.668331	22.844402	13.184
Melotte 22 BPL111	56.719055	24.288054	13.327
Melotte 22 BPL116	56.730465	24.188021	12.882
Melotte 22 BPL118	56.744938	24.368979	12.233
Melotte 22 BPL121	56.754147	24.982632	12.335
Melotte 22 BPL125	56.782818	24.393866	13.102
Melotte 22 BPL130	56.799099	24.225414	13.881
Melotte 22 BPL134	56.814346	24.391975	12.81
Melotte 22 BPL136	56.818508	24.747318	12.508
Melotte 22 BPL138	56.825546	24.230921	12.285
Melotte 22 BPL139	56.843243	24.23859	13.21
Melotte 22 BPL145	56.868435	24.675905	12.873
Melotte 22 BPL147	56.883312	24.173588	12.833
Melotte 22 BPL150	56.906883	24.406471	12.833
Melotte 22 BPL162	56.985966	24.258871	13.308
Melotte 22 BPL164	56.997372	24.593704	13.602
Melotte 22 BPL167	57.036713	25.029392	11.254
Melotte 22 BPL170	57.064503	25.243538	12.987
Melotte 22 BPL174	57.089699	24.578793	12.959
Melotte 22 BPL177	57.098423	24.376467	13.941
Melotte 22 BPL183	57.151382	25.261534	13.886
Melotte 22 BPL186	57.16914	25.022268	13.613
Melotte 22 BPL189	57.183495	25.106304	12.622
Melotte 22 BPL193	57.214775	24.20483	11.26
Melotte 22 BPL194	57.230083	22.845106	13.118
Melotte 22 BPL200	57.297535	24.240187	12.847
Melotte 22 BPL203	57.336147	24.876501	13.754
Melotte 22 BPL210	57.387951	24.218021	13.754
Melotte 22 BPL220	57.498066	24.196119	13.554
Melotte 22 BPL221	57.506973	24.613527	13.563
Melotte 22 BPL225	57.544861	24.478228	12.884
Melotte 22 BPL227	57.575878	24.587667	12.891
Melotte 22 BPL231	57.637821	24.33943	12.547
Melotte 22 BPL232	57.799484	23.745398	13.418
Melotte 22 BPL236	57.8927	23.797207	13.011
Melotte 22 BPL238	57.91328	23.855104	12.947
Melotte 22 BPL239	57.926292	24.361547	12.734
Melotte 22 BPL246	57.993095	23.972116	12.754
Melotte 22 BPL252	58.01865	24.244398	12.93
Melotte 22 BPL256	58.045849	24.156031	12.928
Melotte 22 DH 219	55.59219	25.065676	13.755
Melotte 22 DH 225	55.61499	25.047003	10.065

Melotte 22 DH 233	55.653927	25.232704	13.291
Melotte 22 DH 257	55.806698	25.27014	9.665
Melotte 22 DH 283	55.92976	24.54895	13.108
Melotte 22 DH 290	55.949848	25.053202	10.832
Melotte 22 DH 342	56.116299	23.999977	13.493
Melotte 22 DH 367	56.25502	25.351633	13.04
Melotte 22 DH 384	56.318409	23.567165	13.516
Melotte 22 DH 392	56.353249	24.345961	12.245
Melotte 22 DH 396	56.391602	23.185205	13.007
Melotte 22 DH 412	56.491261	24.144756	13.677
Melotte 22 DH 440	56.590103	23.066956	12.748
Melotte 22 DH 441	56.592484	23.878132	12.088
Melotte 22 DH 467	56.681622	23.995152	11.575
Melotte 22 DH 487	56.759743	23.543383	13.352
Melotte 22 DH 498	56.789635	23.432364	13.053
Melotte 22 DH 523	56.893787	24.039755	12.801
Melotte 22 DH 550	57.031975	25.315348	10.336
Melotte 22 DH 554	57.0424	23.001144	11.004
Melotte 22 DH 555	57.042397	23.988985	13.512
Melotte 22 DH 568	57.082642	23.603336	11.472
Melotte 22 DH 576	57.099663	23.135681	13.152
Melotte 22 DH 585	57.163754	24.838917	13.421
Melotte 22 DH 598	57.254772	23.637695	13.583
Melotte 22 DH 610	57.327724	23.780285	13.42
Melotte 22 DH 626	57.383984	23.271732	13.44
Melotte 22 DH 641	57.481174	24.101456	12.63
Melotte 22 DH 644	57.490124	23.724539	13.388
Melotte 22 DH 650	57.520805	23.304855	13.4
Melotte 22 DH 655	57.535908	24.671646	13.386
Melotte 22 DH 659	57.551868	23.926731	12.123
Melotte 22 DH 660	57.552471	23.813648	13.585
Melotte 22 DH 683	57.676811	24.215456	13.162
Melotte 22 DH 687	57.727699	24.365543	12.776
Melotte 22 DH 691	57.765015	24.543182	12.414
Melotte 22 HCG 65	55.515965	24.712622	9.916
Melotte 22 HCG 71	55.589748	24.66465	10.718
Melotte 22 HCG 74	55.630009	24.822643	13.129
Melotte 22 HCG 97	55.773048	24.824587	10.789
Melotte 22 HHJ 10	57.146606	22.895149	13.747
Melotte 22 HHJ 14	56.302544	23.895882	13.883
Melotte 22 HHJ 16	56.874683	23.554222	13.82
Melotte 22 HHJ 21	57.020718	23.403799	13.94
Melotte 22 HHJ 24	56.19223	24.384195	13.788
Melotte 22 HHJ 27	56.49041	24.051449	13.787
Melotte 22 HHJ 30	56.629223	23.026346	13.728
Melotte 22 HHJ 33	56.589149	23.085882	13.703
Melotte 22 HHJ 36	57.315067	23.380386	13.413
Melotte 22 HHJ 37	56.789215	24.259703	13.563
Melotte 22 HHJ 40	55.915485	23.692404	13.573

Melotte 22 HHJ 43	55.931335	24.213951	13.554
Melotte 22 HHJ 44	57.177849	24.455458	13.492
Melotte 22 HHJ 45	55.675457	25.19692	13.39
Melotte 22 HHJ 46	56.157349	24.427465	13.518
Melotte 22 HHJ 47	56.580856	23.015503	13.178
Melotte 22 HHJ 50	55.874538	24.656565	13.425
Melotte 22 HHJ 51	57.338516	24.694727	13.513
Melotte 22 HHJ 56	56.559753	23.850643	12.969
Melotte 22 HHJ 57	56.086048	24.253031	13.099
Melotte 22 HHJ 65	55.837959	24.185894	13.345
Melotte 22 HHJ 68	56.133984	25.136826	13.372
Melotte 22 HHJ 69	55.415966	24.875067	13.364
Melotte 22 HHJ 71	55.7985	24.114626	13.165
Melotte 22 HHJ 73	56.900127	23.474146	13.284
Melotte 22 HHJ 75	56.686565	24.74958	13.354
Melotte 22 HHJ 76	55.869724	24.151775	13.24
Melotte 22 HHJ 79	57.356651	23.047304	13.206
Melotte 22 HHJ 86	57.203255	23.413395	13.208
Melotte 22 HHJ 87	56.617348	22.816141	13.228
Melotte 22 HHJ 92	56.799419	24.231649	13.134
Melotte 22 HHJ 94	56.915768	23.001301	13.218
Melotte 22 HHJ 95	56.730438	23.380434	13.332
Melotte 22 HHJ 99	56.362411	24.224075	13.287
Melotte 22 HCG 100	55.790607	24.69249	11.42
Melotte 22 HCG 102	55.800495	24.745934	11.687
Melotte 22 HCG 103	55.804447	24.655403	11.293
Melotte 22 HCG 106	55.835712	24.443079	13.155
Melotte 22 HCG 109	55.867493	24.891973	12.168
Melotte 22 HCG 123	55.925556	24.573168	10.955
Melotte 22 HCG 124	55.912655	23.734838	12.266
Melotte 22 HCG 125	55.951855	25.043606	11.957
Melotte 22 HCG 128	55.965637	24.237814	12.384
Melotte 22 HCG 129	55.986244	24.993528	11.511
Melotte 22 HCG 133	55.988647	24.222366	12.37
Melotte 22 HCG 134	56.009483	25.064943	11.271
Melotte 22 HCG 135	55.98748	23.95166	12.304
Melotte 22 HCG 140	56.041294	24.267807	11.53
Melotte 22 HCG 143	56.09745	25.358377	11.613
Melotte 22 HCG 144	56.068531	23.61783	11.886
Melotte 22 HCG 145	56.073944	24.446377	11.686
Melotte 22 HCG 146	56.079422	24.588455	12.437
Melotte 22 HCG 148	56.102833	24.864859	11.943
Melotte 22 HCG 149	56.103378	24.768394	11.011
Melotte 22 HCG 150	56.106625	24.681362	11.651
Melotte 22 HCG 155	56.08691	23.561136	12.01
Melotte 22 HCG 156	56.11198	24.408831	11.45
Melotte 22 HCG 161	56.151157	23.50309	11.662
Melotte 22 HCG 166	56.199333	24.214663	12.45
Melotte 22 HCG 171	56.233303	23.931536	11.916

Melotte 22 HCG 172	56.254707	24.778107	12.57
Melotte 22 HCG 176	56.278255	23.614344	12.661
Melotte 22 HCG 178	56.32077	25.263279	11.179
Melotte 22 HCG 180	56.304733	24.256607	13.168
Melotte 22 HCG 181	56.319359	24.575708	11.43
Melotte 22 HCG 183	56.317177	24.121185	11.627
Melotte 22 HCG 185	56.300629	23.364792	12.244
Melotte 22 HCG 194	56.402985	24.651888	11.354
Melotte 22 HCG 196	56.412647	25.224415	10.938
Melotte 22 HCG 202	56.469788	23.465073	12.326
Melotte 22 HCG 205	56.487328	23.02478	12.578
Melotte 22 HCG 206	56.514374	24.349207	12.557
Melotte 22 HCG 209	56.536221	24.675913	12.706
Melotte 22 HCG 214	56.521854	22.981655	10.5
Melotte 22 HCG 218	56.597767	24.030945	12.853
Melotte 22 HCG 219	56.605766	24.160105	11.136
Melotte 22 HCG 236	56.701302	24.301674	11.717
Melotte 22 HCG 240	56.708675	23.532301	12.391
Melotte 22 HCG 241	56.725128	25.245825	11.489
Melotte 22 HCG 244	56.723351	24.287514	11.212
Melotte 22 HCG 245	56.703251	23.068752	11.423
Melotte 22 HCG 246	56.743908	24.461136	12.15
Melotte 22 HCG 247	56.737892	23.250679	11.128
Melotte 22 HCG 248	56.769783	25.380619	11.262
Melotte 22 HCG 253	56.783916	24.306835	11.901
Melotte 22 HCG 254	56.795921	24.23103	13.389
Melotte 22 HCG 258	56.806915	23.831503	11.086
Melotte 22 HCG 261	56.845722	24.848948	11.851
Melotte 22 HCG 263	56.857452	25.142515	11.446
Melotte 22 HCG 266	56.844494	23.735275	12.438
Melotte 22 HCG 269	56.861523	23.634071	12.288
Melotte 22 HCG 270	56.849384	23.149191	12.072
Melotte 22 HCG 273	56.877476	24.37055	11.371
Melotte 22 HCG 277	56.8894	23.692505	10.929
Melotte 22 HCG 279	56.899403	24.874151	12.839
Melotte 22 HCG 282	56.913971	24.458933	12.162
Melotte 22 HCG 284	56.89492	22.801352	12.147
Melotte 22 HCG 287	56.941284	24.633736	12.544
Melotte 22 HCG 292	56.957409	24.428701	12.693
Melotte 22 HCG 295	56.96228	24.505226	11.467
Melotte 22 HCG 302	56.980289	23.318333	12.149
Melotte 22 HCG 307	57.033176	23.739923	12.181
Melotte 22 HCG 309	57.024258	23.034147	11.55
Melotte 22 HCG 311	57.055473	23.979725	12.387
Melotte 22 HCG 313	57.084534	24.915321	11.596
Melotte 22 HCG 315	57.057373	23.633196	12.108
Melotte 22 HCG 317	57.108486	25.244755	11.089
Melotte 22 HCG 321	57.085754	23.517082	13.509
Melotte 22 HCG 322	57.105152	24.240564	11.99

Melotte 22 HCG 323	57.094372	22.8727	11.484
Melotte 22 HCG 324	57.129375	24.281488	11.34
Melotte 22 HCG 327	57.132645	24.033014	12.846
Melotte 22 HCG 328	57.123997	23.968334	13.023
Melotte 22 HCG 332	57.110798	23.191612	11.361
Melotte 22 HCG 333	57.168446	24.609516	12.331
Melotte 22 HCG 335	57.147865	24.200916	13.212
Melotte 22 HCG 337	57.166275	24.211941	11.85
Melotte 22 HCG 339	57.175571	25.007936	11.72
Melotte 22 HCG 341	57.156845	22.76932	10.65
Melotte 22 HCG 343	57.17075	23.238203	12.034
Melotte 22 HCG 346	57.188961	24.624012	13.174
Melotte 22 HCG 349	57.238956	24.328848	11.014
Melotte 22 HCG 351	57.254082	24.902826	11.814
Melotte 22 HCG 353	57.254169	22.980446	11.15
Melotte 22 HCG 354	57.27441	23.739756	10.786
Melotte 22 HCG 355	57.295956	24.347589	12.178
Melotte 22 HCG 357	57.274666	23.106136	12.244
Melotte 22 HCG 362	57.318363	24.063673	10.754
Melotte 22 HCG 363	57.339542	23.651802	11.985
Melotte 22 HCG 370	57.365147	24.531731	11.258
Melotte 22 HCG 371	57.385563	23.928522	12.436
Melotte 22 HCG 372	57.387638	24.534067	11.738
Melotte 22 HCG 373	57.400475	23.93984	12.276
Melotte 22 HCG 375	57.40218	24.303963	12.434
Melotte 22 HCG 380	57.482403	24.742126	11.568
Melotte 22 HCG 382	57.509048	23.862457	11.992
Melotte 22 HCG 394	57.563602	24.226727	12.377
Melotte 22 HCG 396	57.604778	23.928335	12.765
Melotte 22 HCG 414	57.742352	23.92857	12.771
Melotte 22 HCG 415	57.739239	24.108593	11.838
Melotte 22 HCG 422	57.79808	24.387018	11.301
Melotte 22 HCG 424	57.829441	24.170362	11.4
Melotte 22 HCG 430	57.855595	23.889364	10.599
Melotte 22 HCG 440	57.97934	23.961754	12.619
Melotte 22 HCG 441	57.974667	24.047691	11.514
Melotte 22 HHJ 104	56.67992	23.622803	13.1
Melotte 22 HHJ 105	56.58897	24.564585	13.075
Melotte 22 HHJ 106	56.364624	23.632532	13.261
Melotte 22 HHJ 113	56.270782	23.768494	12.863
Melotte 22 HHJ 116	57.211086	23.075073	13.11
Melotte 22 HHJ 120	55.46796	24.699417	13.052
Melotte 22 HHJ 122	56.966473	23.663397	13.067
Melotte 22 HHJ 127	56.496639	23.813051	13.078
Melotte 22 HHJ 130	56.413677	24.139048	13.061
Melotte 22 HHJ 139	56.261963	25.088852	12.851
Melotte 22 HHJ 140	56.648033	24.026529	12.779
Melotte 22 HHJ 142	57.380081	23.68885	12.761
Melotte 22 HHJ 151	57.067009	23.587627	12.652

Melotte 22 HHJ 152	56.936039	23.700907	12.698
Melotte 22 HHJ 156	57.037277	23.706537	12.767
Melotte 22 HHJ 158	57.374203	23.648733	12.7
Melotte 22 HHJ 161	56.615376	23.812695	12.648
Melotte 22 HHJ 166	56.466434	25.1672	12.811
Melotte 22 HHJ 171	57.094582	23.461969	12.81
Melotte 22 HHJ 174	56.742352	23.560827	12.854
Melotte 22 HHJ 183	56.225384	24.446379	12.75
Melotte 22 HHJ 184	57.140739	24.03306	12.931
Melotte 22 HHJ 188	57.07233	23.806593	12.784
Melotte 22 HHJ 190	56.114559	24.238113	12.658
Melotte 22 HHJ 192	57.364906	24.403845	12.68
Melotte 22 HHJ 198	56.854614	24.254812	13.055
Melotte 22 HHJ 203	56.81406	23.435032	12.501
Melotte 22 HHJ 206	55.819164	23.833788	12.4
Melotte 22 HHJ 207	57.191715	24.170187	12.664
Melotte 22 HHJ 208	56.696598	25.348185	12.532
Melotte 22 HHJ 217	56.050545	23.877096	12.566
Melotte 22 HHJ 222	56.747803	24.879539	12.351
Melotte 22 HHJ 225	57.038399	23.977999	12.647
Melotte 22 HHJ 231	57.256214	24.193983	12.511
Melotte 22 HHJ 232	57.063499	23.4349	12.565
Melotte 22 HHJ 240	57.02766	24.001932	12.544
Melotte 22 HHJ 243	56.110554	24.486536	12.082
Melotte 22 HHJ 245	57.3857	23.411463	12.354
Melotte 22 HHJ 247	56.71917	23.645351	12.198
Melotte 22 HHJ 249	56.602627	24.479601	12.538
Melotte 22 HHJ 252	56.751217	24.473555	12.252
Melotte 22 HHJ 256	57.51627	23.976154	12.484
Melotte 22 HHJ 257	56.732403	23.940079	12.314
Melotte 22 HHJ 269	56.236198	23.606585	12.332
Melotte 22 HHJ 273	56.340298	24.543709	12.312
Melotte 22 HHJ 274	56.244091	23.928066	12.111
Melotte 22 HHJ 276	56.197186	24.010527	12.325
Melotte 22 HHJ 299	56.747135	24.028616	12.11
Melotte 22 HHJ 303	56.582733	24.983765	11.965
Melotte 22 HHJ 308	57.320011	24.016356	12.24
Melotte 22 HHJ 326	56.612507	24.453926	12.047
Melotte 22 HHJ 336	57.063622	23.701002	11.778
Melotte 22 HHJ 353	57.242847	23.094244	11.669
Melotte 22 HHJ 363	56.517899	23.928019	11.816
Melotte 22 HHJ 367	56.574726	24.686003	11.688
Melotte 22 HHJ 374	55.932117	24.487711	11.497
Melotte 22 HHJ 427	56.855595	24.04917	11.808
Melotte 22 HHJ 435	56.527157	23.838995	10.919
Melotte 22 HHJ 438	56.943283	24.050699	11.327
J034147.08+250021.9	55.44617	25.006088	12.936
J034242.84+251651.8	55.678482	25.281044	10.74
J034313.46+241101.1	55.806074	24.183638	13.642

J034327.88+250141.1	55.866184	25.028078	13.439
J034410.96+244845.6	56.045668	24.812675	13.02
J034411.28+245234.1	56.047018	24.876139	13.434
J034414.65+234940.1	56.06103	23.8278	13.546
J034419.69+235345.7	56.082061	23.896022	13.262
J034439.62+243143.9	56.165097	24.528856	11.822
J034451.52+250516.5	56.214654	25.087908	12.788
J034453.22+240106.4	56.221754	24.018447	13.135
J034454.79+240636.8	56.228307	24.11021	13.996
J034456.31+240649.2	56.234631	24.113664	13.638
J034457.35+235932.2	56.238939	23.992288	11.867
J034506.56+244042.6	56.277348	24.678501	13.314
J034508.40+232500.9	56.285003	23.416922	13.534
J034508.76+245031.4	56.286513	24.842062	12.049
J034512.08+243018.0	56.300335	24.505007	11.852
J034519.97+242824.3	56.333216	24.473427	12.414
J034524.70+243846.3	56.352915	24.646191	13.645
J034537.96+242003.3	56.408164	24.334261	11.293
J034538.99+235700.9	56.412462	23.950246	13.238
J034542.87+232012.2	56.428623	23.336735	13.217
J034546.90+235300.3	56.445426	23.883426	13.652
J034549.37+230834.7	56.455722	23.142983	12.659
J034549.94+231944.8	56.458091	23.329107	13.634
J034551.03+233717.0	56.462634	23.621389	12.575
J034551.10+242610.9	56.462911	24.436349	13.746
J034551.34+241744.1	56.463907	24.295591	12.662
J034556.75+242207.7	56.48644	24.368806	13.486
J034557.09+242100.8	56.487877	24.350217	12.783
J034605.70+243649.7	56.523741	24.613793	13.037
J034612.66+233513.9	56.55276	23.587189	12.923
J034622.46+232908.1	56.593602	23.485583	12.754
J034624.14+242140.1	56.600585	24.361143	10.247
J034634.81+225607.3	56.645029	22.93536	10.85
J034640.02+234658.4	56.666765	23.782902	11.92
J034651.44+240616.0	56.714323	24.10445	13.272
J034653.97+240757.0	56.724855	24.132488	13.143
J034658.26+240141.4	56.742752	24.028157	12.964
J034700.35+235248.4	56.751459	23.880116	13.098
J034705.79+234534.8	56.774117	23.759669	13.961
J034706.10+234520.2	56.775415	23.755617	13.143
J034709.19+240307.6	56.788297	24.052106	11.653
J034713.17+240045.2	56.804882	24.012566	13.828
J034722.02+232136.4	56.841771	23.360115	12.607
J034722.28+241659.8	56.842815	24.283267	13.922
J034723.98+235452.0	56.849914	23.914442	8.268
J034727.63+224953.1	56.865121	22.831426	12.287
J034729.36+240651.2	56.872346	24.114229	12.796
J034729.48+241219.7	56.872841	24.205471	13.372
J034729.92+240549.4	56.874662	24.097047	13.145

J034731.65+235219.0	56.881871	23.871943	12.743
J034732.14+242418.2	56.883915	24.405069	13.042
J034732.19+231823.4	56.884117	23.306506	12.489
J034737.36+252002.3	56.90565	25.333969	12.404
J034738.37+243559.6	56.909864	24.599894	13.408
J034744.44+243655.6	56.935158	24.615451	13.132
J034745.75+240536.9	56.940623	24.093596	12.352
J034755.60+232753.9	56.981647	23.464982	9.397
J034805.87+235300.8	57.024451	23.883565	13.253
J034806.41+240651.6	57.026717	24.114341	12.729
J034818.02+235329.0	57.075083	23.891394	10.955
J034845.33+233124.8	57.188856	23.523547	13.154
J034859.77+231207.2	57.249049	23.201993	13.158
J034941.14+231459.4	57.421408	23.249825	13.056
J034942.72+241907.3	57.427987	24.318703	11.95
J034952.44+240342.9	57.46849	24.061919	13.97
J035050.95+235844.0	57.712306	23.978889	12.353
J035054.98+243303.7	57.729086	24.551025	12.95
J035057.40+242444.4	57.739166	24.412337	13.097
J035103.29+233500.0	57.763691	23.583324	13.365
Melotte 22 PELS 142	56.811691	25.37184	9.517