Preliminary SFOM

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ACWG 2.5
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ExoCat (2347 stars within 30 pc, 53 parameters)

ExoPlanet Exploration Program

HIP	HD	GL/GJ	GL/LTT	COMMON	WDS	sep(")	dM(mag)	NPLANETS	RAhms	DEdms	RA(ICRS)	DE(ICRS)
57	224789	___	___	___	___	___	___	___	00 00 40.39	-69 40 32.9	0.16828557	-69.675801
169	224953	GJ 1294A	LTT 9859	___	00021-6817	___	___	___	00 02 08.41	-68 16 48.7	0.53502093	-68.280206
171	224930	GL 914A	LHS 101	___	00022+2705	0.8	3.07	___	00 02 09.65	+27 05 04.2	0.54018776	27.0844891
263	___	___	___	___	___	___	___	___	00 03 19.02	+04 41 13.7	0.82923787	4.68713578
375	___	___	___	___	00047+3416	___	___	___	00 04 40.15	+34 16 17.4	1.16729373	34.2715057
400	225261	G 130-40	LTT 10010	___	___	___	___	___	00 04 56.08	+23 16 10.7	1.23366004	23.2696474

Catalog is all Hipparcos stars within 30 pc, corrected for errors.
Star parameters are current best estimates.

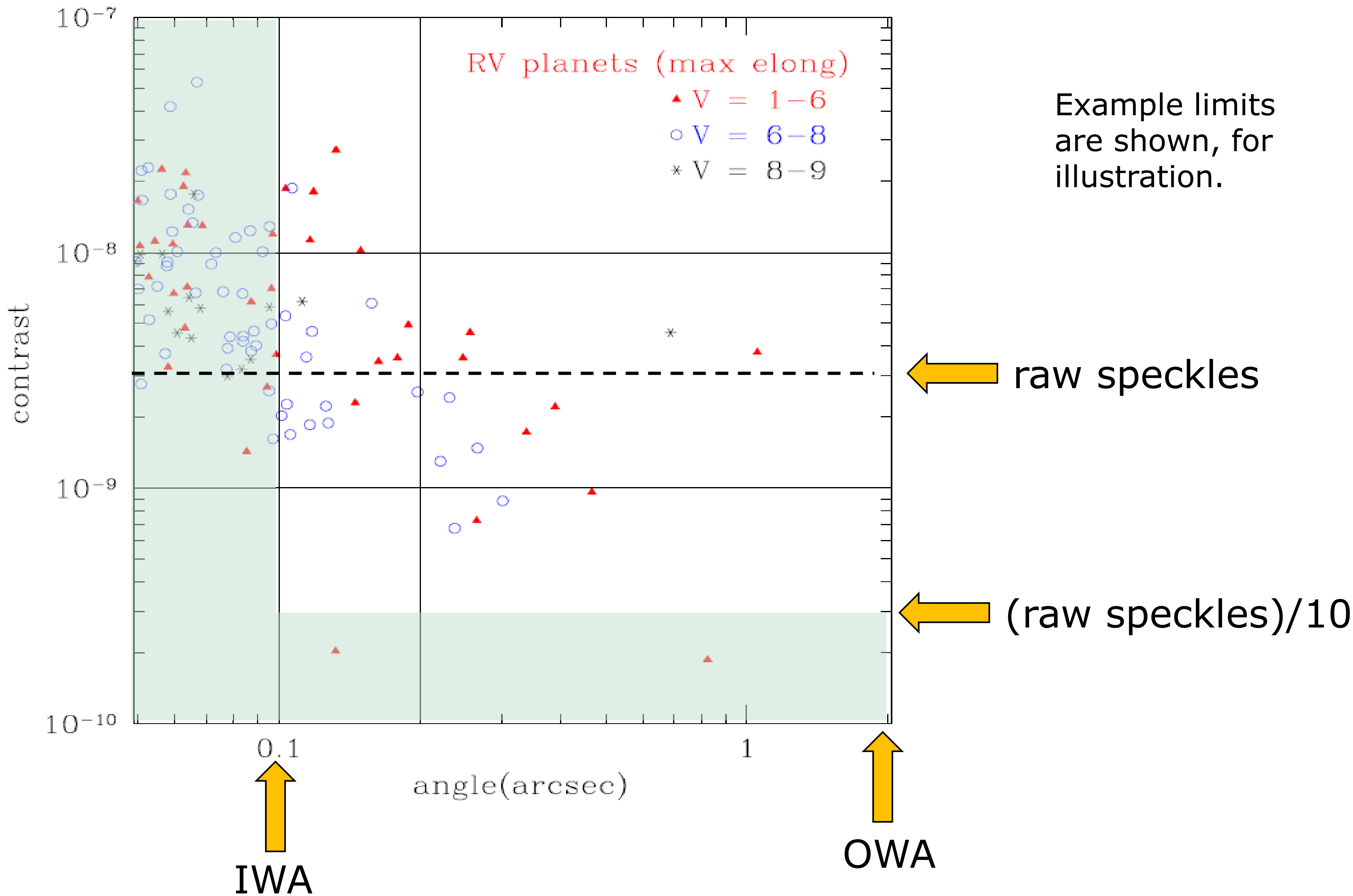
Authorship: Maggie Turnbull, Geoff Bryden, Maggie Thompson, Brian Mason.

RV Cat (436 RV planets)

row	NAME	MASS (Jup)	RADIUS (Earth)	ALBEDO	PERIOD (days)	SMA (AU)	ECC	s (arcsec)	SPEC	VMAG (mag)	DIST (pc)	MV (mag)	L (suns)
1	HD62509	2.9	13.03	0.1	589.6	1.69	0.02	0.163	K0IIIb	1.15	10.36	1.07	42.22
2	HD12929	1.8	12.93	0.1	380.8	1.2	0.25	0.059	K2III	2.00	20.18	0.47	87.30
3	HR4057	8.78	12.87	0.1	428.5	1.19	0.14	0.031	K1IIIb	2.12	38.52	-0.81	259.39
4	HR8974	1.85	12.93	0.1	903.3	2.05	0.05	0.145	K1IV	3.22	14.10	2.47	11.98
5	HD163917	24	11.66	0.1	530.3	1.9	0.13	0.041	G9III	3.31	46.21	-0.01	115.15
6	HD163917	27	11.42	0.1	3186	6.1	0.18	0.132	G9III	3.31	46.21	-0.01	115.15
7	HIP75458	8.82	12.87	0.1	510.7	1.28	0.71	0.041	K2III	3.31	31.03	0.85	62.86
8	HD28305	7.6	12.96	0.1	594.9	1.93	0.15	0.043	K0III	3.53	44.96	0.27	90.50
9	HD22049	1.55	12.91	0.45	2502	3.39	0.70	1.054	K2Vk:	3.73	3.22	6.19	0.34
10	7CMa	2.6	13.00	0.26	763	1.9	0.14	0.096	K1III	3.95	19.75	2.47	12.39
433	HIP57050	0.298	12.15	0.32	41.4	0.16	0.31	0.014	M4	11.88	11.10	11.65	0.005
434	GJ317	1.8	12.93	0.27	691.8	1.15	0.11	0.075	M3.5	11.98	15.31	11.05	0.01
435	GJ317	2	12.95	0.2	10000	30	0.81	1.959	M3.5	11.98	15.31	11.05	0.01
436	Gl179	0.82	12.81	0.2	2288	2.41	0.21	0.196	M3.5	12.02	12.29	11.57	0.01

Author is Dmitry Savransky.

RV Planets at Maximum Elongation



Example limits are shown, for illustration.

Integration time: photon-noise case

$$\text{signal} = n_{pl} \times t \qquad \text{(elec)}$$

$$\text{noise}^2 = n_{total} \times t \qquad \text{(elec)}$$

$$t = (SNR_0)^2 \times n_{total} / (n_{pl})^2 \qquad \text{(sec)}$$

Exoplanet yield calculation: target count rates

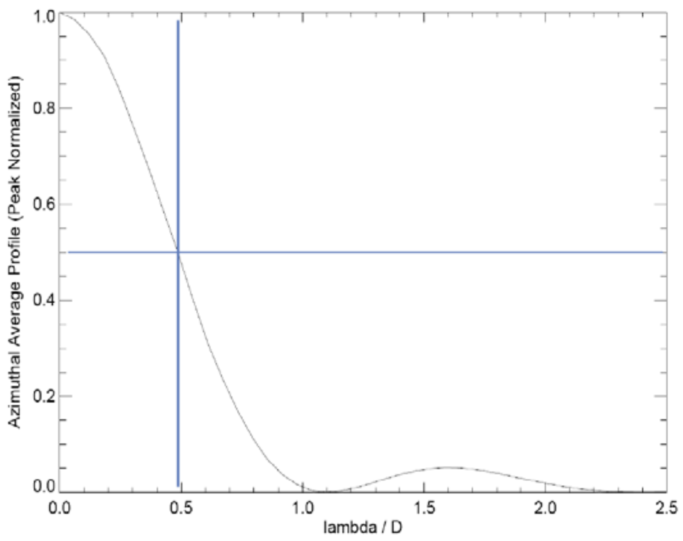
$$n_{star} = 10^{p-0.4mV} \times BW \times A \times \eta \times f_{psf} \quad = 2.89 \times 10^{6} \qquad (elec/s)$$

$$n_{pl} = n_{star} \times C_{pl} = 1.16 \times 10^{-2} \qquad (elec/s)$$

I count the electrons that fall within the FWHM boundary of the PSF. For AFTA, without a coronagraph, the width is FWHM = 0.96λ/D = 0.045 arcsec at 550 nm.

The fraction of collected photons in the FWHM is f = 0.35.

Both values are from John Krist.
Both values will be different for each coronagraph.



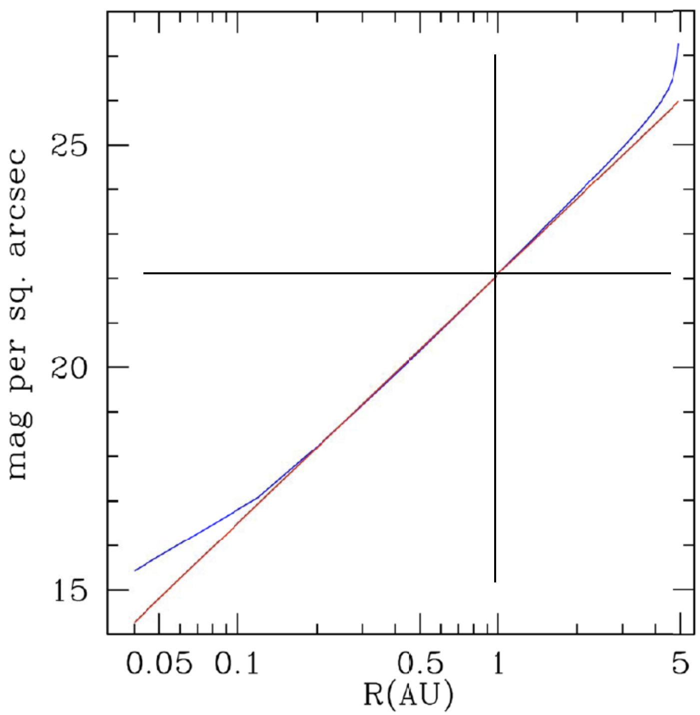
Background count rates

$m_V(\text{local zodi}) = 22.1 \text{ mag/arcsec}^2$

$\Omega_{tel} = (\pi/4)\times(\text{FWHM})^2$

$n(\text{local zodi}) = \Omega_{tel} \times 10^{p-0.4mV} \times BW \times A \times \eta$ (elec/s)

$n_{zodi} = 2 \times n(\text{local zodi}) = 1.15 \times 10^{-2}$ (elec/s)



$n_{spec} = 0.010$ (elec/s)

$m_{pix} = (\pi/4)\times(2.5)^2 = 4.9$ (pixels)

$n_{min} = n_{spec} \times f_{pp}$ (elec/s)

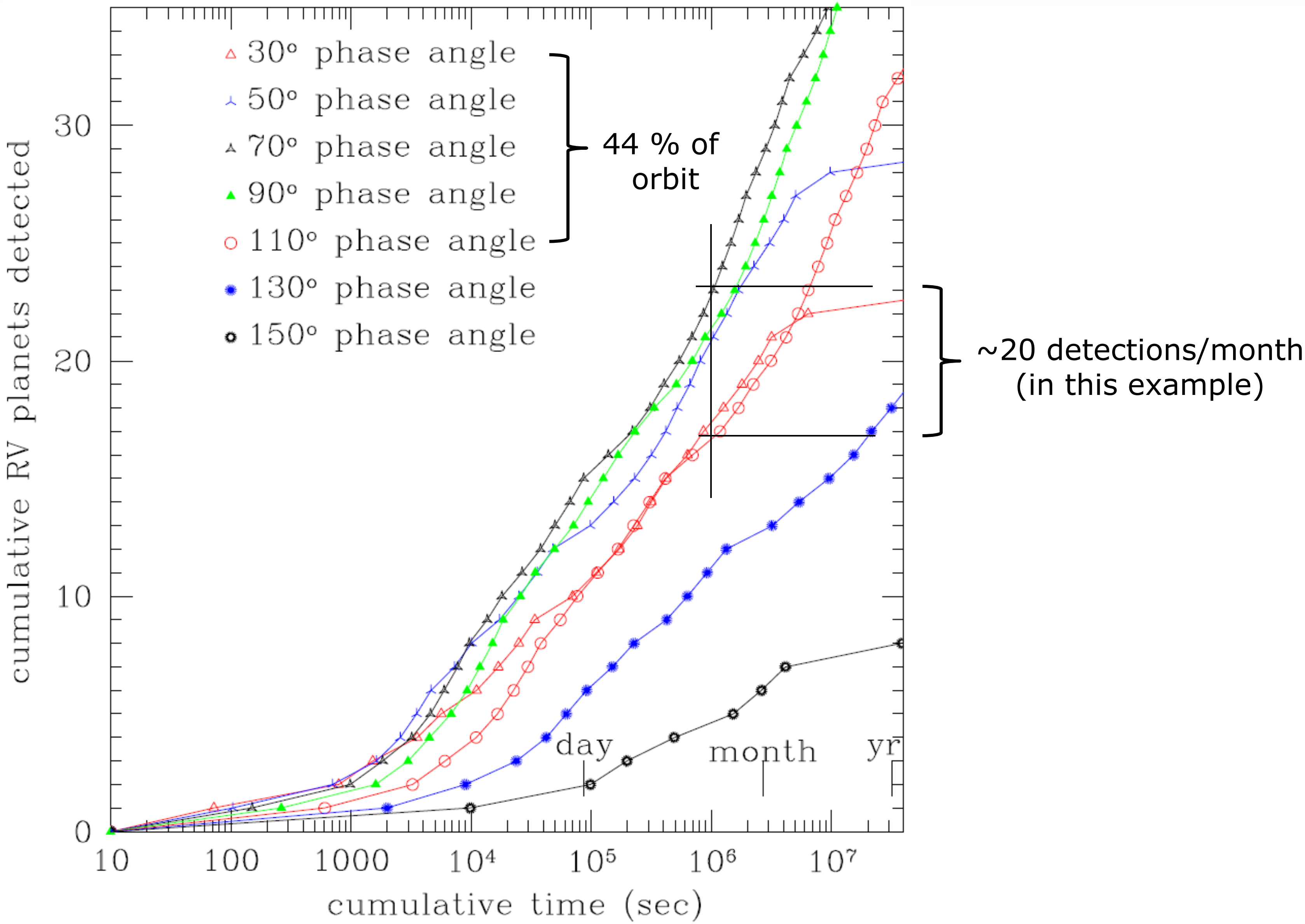
Bkgd & detector count rates

$$n_{total} = [\, n_{pl} + n_{zodi} + n_{spec} \times (1 + f_{pp}) + D_c \times m_{pix} + CIC \times m_{pix} / t_{frame} \,] \times ENF^2$$

$$+ (N_R/G)^2 \times m_{pix} / t_{frame} \quad \text{(elec/s)}$$

parameter	units	CCD typical value	EMCCD typical value
n_{pl}	elec/sec	0.012	0.012
n_{zodi}	elec/sec	0.012	0.012
n_{spec}	elec/sec	0.010	0.010
m_{pix}	pixels	5	5
D_c	elec/(pixel sec)	0.001	0.001
N_R	RMS elec/(pixel frame)	3	3
t_{frame}	sec	300	300
CIC	elec/(pixel frame)	0	0.001
ENF		1	1.414
G		1	1000
t	**sec**	**33,000**	**14,000**

Example: cumulative detections vs time



Next steps

- Example above was for RV planets, 60-deg inclination, 0.10 arcsec IWA, etc
- Can extend to random inclinations & orbital phases, for RV planets
- Can also extend to model planets, range of radii, sma, albedo, etc
- Can use BW ~ 10% for detection, or ~2% for spectra (25 times longer integ.)
- Can estimate debris disk detection threshold surface brightness

- Could use best of either CCD or EMCCD
- Could shift IWA or speckle level to estimate d(science)/d(jitter)

- Do all steps for each coronagraph