

The WW Survey

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VVV: The VISTA Variables in the Via Láctea

Pls: D. Minniti, P. Lucas

DR1: http://archive.eso.org/cms/eso-data/eso-data-products (Saito et al. 2012) > 300 deg² bulge: $-10^{\circ} < I < +10^{\circ} -10^{\circ} < b < +5^{\circ}$ (Minniti et al. 2010) > 220 deg² disk: $295^{\circ} < I < 350^{\circ} -2^{\circ} < b < +2^{\circ}$

Scorpius

Sagittarius

Y, Z, J, H, Ks filters – ~4mag deeper than 2MASS
~100 epochs in Ks – variability campaign ongoing

Credit: ESO/Nick Risinger (skysurvey.org)



VVV vs. 2MASS

Sky coverage: 2MASS complete sky VVV ~1.3%

Depth: VVV is ~4mag deeper







R. Saito

VVV: The VISTA Variables in the Via Láctea

VVV limiting magnitudes



Completeness tests

M. Hempel



vvvsurvey.org



2MASS vs VVV limit for

RR Lyrae

60°

90



270

Norma A

685trarius A

Orion Spur

30,000 ly

eus Arm

Outer Arm

120

Centaurus Anm

240

Scutu





VVV: RR Lyrae variables

RR Lyr variables in the bulge \rightarrow 3D structure





Globular Clusters \mathbb{N}





































































































































































VVV Survey: strategy & status

Year 1 (2010) – multicolor maps → completed
Z, Y, J, H, Ks single epoch observations – bulge + disk
> 6 epochs in Ks for bulge + disk K_{lim}=18/20 mag

✓ Year 2 – 5 (2011 – 2014) – variability \rightarrow ongoing

≻~95 epochs for bulge in Ks

- ➤ ~85 epochs for disk in Ks
- Currently most tiles >20 epochs

Proper motions



Red Clump in nearby galaxies in near-IR



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- **1. Extinction correction** select the reddening law
 - > $A_{K} = 0.528 * [(J-Ks)_{0} (J-Ks)]$ (Nishiyama et al. 2009)
 - Mean intrinsic color for RC in Baade's Window $(J-Ks)_0 = 0.68$
- 2. Luminosity function -2^{nd} order polynomial + Gaussian

$$N(K_{s_0}) = a + bK_{s_0} + cK_{s_0}^2 + \frac{N_{RC}}{\sigma_{RC}\sqrt{2\pi}} \exp\left[\frac{(K_{s_0}^{RC} - K_{s_0})^2}{2\sigma_{RC}^2}\right]$$

- **3**. The peak of the Gaussian is the m(RC)
- 4. Distance modulus: $(m M)_{0,target} = m_{K}^{RC} M_{K}^{RC} A_{K}$

 M_{K}^{RC} – RC zero point:–1.55 (assume Z_o, 10Gyr; Pietrinferni+04) ΔM_{K}^{RC} – population correction for the zero point M_{K}^{RC}



K-band RC magnitude

Alves 2000; Alves et al. 2002 – 2MASS & CIO + Hipparcos (Solar Neighb.) Grocholski & Sarajedini 2002 – WIYN Open clusters Pietrzynski et al. 2003 – LMC, SMC, Fornax, Carina (Araucaria project) Salaris & Girardi 2002 – population effects (theoretical) Percival & Salaris 2003 – population effects (empirical + models) Laney et al. 2012 – SAAO + Hipparcos (Solar Neighbourhood)



VVV Bulge area: each tile $1.5 \times 1 \text{ deg}^2$



	-		_		-				_		_	-	_	_			
+4	_	396	395	394	393	392	391	390	389	388	387	386	385	384	383	_	Extinction
14	_	382	381	380	379	378	377	376	375	374	373	372	371	370	369	1	map
+2	1	368	367	366	365	364	363	362	361	360	359	358	357	356	355	-	resolution
	-	354	353	352	351	350	349	348	347	346	345	344	343	342	341	1	
+0	1	340	339	338	337	336	335	334	333	332	331	330	329	328	327	-	2'x2'
	1	326	325	324	323	322	321	320	319	318	317	316	315	314	313	Ξ	
-2	-	312	311	310	309	308	307	306	305	304	303	302	301	300	299	-	
	_	298	297	296	295	294	293	292	291	290	289	288	287	286	285	-	
-4	_	284	283	282	281	280	279	278	277	276	275	274	273	272	271	-	
	2	270	269	268	267	266	265	264	263	262	261	260	259	258	257	-	4'x4'
-6		256	255	254	253	252	251	250	249	248	247	246	245	244	243	-	
	2	242	241	240	239	238	237	236	235	234	233	232	231	230	229		
-8	-	228	227	226	225	224	223	222	221	220	219	218	217	216	215		6'x6'
10	2	214	213	212	211	210	209	208	207	206	205	204	203	202	201	-	
-10	-	L					_	- +	-			-	_	-	-+		

Longitude

350

Latitude

10



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VVV Bulge Extinction Map

BEAM Calculator: http://mill.astro.puc.cl/BEAM/calculator.php





VVV Bulge Extinction Map

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The Galactic Bar





Inner bar flattening





Photometric (VVV) vs. spectroscopic (FLAMES) metallicity





-8.0

The Bulge Metallicity Map

The complete (photometric) metallicity map of the MW bulge BEAM Calculator: http://mill.astro.puc.cl/BEAM/calculator.php



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VVV depth and resolution provides ideal dataset for inner Bulge stellar population and structure studies
RC, eclipsing binaries, RR Lyr

Complexity:

- \succ patchy extinction \rightarrow
- The Bulge Extinction And Metallicity BEAM Calculator: <u>http://mill.astro.puc.cl/BEAM/calculator.php</u>
- > Mix of populations bar/bulge, thin disk and spiral arms
- Kinematics + abundances
- Comparison with models



