J-PAS Collaboration

J-PAS: The Javalambre-Physics of the Accelerated Universe Astrophysical Survey
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Lensing WG formed in late 2013
Abstract

The Javalambre-Physics of the Accelerated Universe Astrophysical Survey (J-PAS) is a narrow band, very wide field Cosmological Survey to be carried out from the Javalambre Observatory in Spain with a purpose-built, dedicated 2.5m telescope and a 4.7\,deg camera with 1.2Gpix. Starting in 2015, J-PAS will observe 8500\,deg\(^2\) of Northern Sky and measure 0.003(1+z) precision photometric redshifts for 9 \times 10^7 LRG and ELG galaxies plus several million QSOs, about 50 times more than the largest current spectroscopic survey, sampling an effective volume of \sim 14 Gpc\(^3\) up to $z = 1.3$. J-PAS will be the first radial BAO experiment to reach Stage IV.

J-PAS will also detect and measure the mass of $7 \times 10^5$ galaxy clusters and groups, setting constrains on Dark Energy which rival those obtained from BAO measurements. Thanks to the superb characteristics of the Javalambre site (seeing $\sim 0.7''$), J-PAS is expected to obtain a deep, sub-arcsec image of the northern sky, which combined with its unique photo-z precision will produce one of the most powerful cosmological lensing surveys before the arrival of Euclid. In addition, J-PAS unprecedented spectral time domain information will enable a self-contained SN survey that, without the need for external spectroscopic follow-up, will detect, classify and measure $\sigma_z \sim 0.5\%$ redshifts for $\sim 4000$ SNeIa and $\sim 900$ core-collapse SNe.

The key to the J-PAS potential is its innovative approach: the combination of 54 145Å filters, placed 100Å apart, and a multi-degree field of view (FOV) is a powerful “redshift machine”, with the survey speed of a 4000 multiplexing low resolution spectrograph, but many times cheaper and much faster to build. Moreover, since the J-PAS camera is equivalent to a very large, 4.7\,deg\(^2\) “IFU”, it will produce a time-resolved, 3D image of the Northern Sky with a very wide range of Astrophysical applications in Galaxy Evolution, the nearby Universe and the study of resolved stellar populations. J-PAS will have a lasting legacy value in many areas of Astrophysics, serving as a fundamental dataset for future Cosmological projects.

Keywords: Dark Energy, Cosmology, SNIa, Large Scale Structure, Baryonic Acoustic Oscillations, Lensing, Dark Matter, Galaxy Evolution, Stars, Solar System, Transients, Telescopes, Instrumentation, Photometric Redshifts
J-PAS = All Sky IFU

J-PAS: Spanish-Brazilian collaboration, ~120 scientists

First Stage-IV Dark Energy probes
- BAO (||, ⊥) + LSS (90M LRGs/ELGs w 0.3% z precision)
- SNIa (6,000 SNe, z<0.4)
- Cluster finding (0.7M halos w M>3e13Msun)
- Weak lensing shear and magnification (r=24ABmag, 5σ)

Unique data for Galaxy Evolution, Local Universe, TD Astronomy
- 300M (500M) galaxies w 1% (3%) z precision upto z~1.3
- Emission-line galaxies at 2<z<2.4 (LAEs)
- z~1 LAEs from J-PAS+GALEX
- Lyman break galaxies at 2<z<3
- 2M QSOs (~20K QSOs at 4<z<7)

54 NB filters (15nm FWHM, 10nm spacing)
5 BB filters (ugr+360nm+950nm)
240-480s exposure
8500 sqdeg (fsky=0.2)
Survey Metric

Wider

Deeper
Optimized Redshift-Survey Machine

4.7sqdeg

+ 5000 multiplex spectrograph

But 10 times cheaper, 2 times faster to build

A few % of the cost of other Stage IV projects

~100M 0.3% redshifts
Site: Excellent Seeing

OAJ: new facility in the Sierra de Javalambre (Teruel, Spain), 1957m altitude, ~53% totally clear nights, very low artificial light contamination

40d02′28.67″ North, 01d00′59.10″ West

Median (mode) seeing 0.71″ (0.58″) in V

Fig. 2.— Distribution of the seeing collected for the 132 nights from March 2008 to September

Moles+2010, PASP, 122, 363
Photometric Calibration

- **J-PAS**
  - JPCam on JST/T250 (2.5m), F#3.5, 1.2Gpix @Cassegrain focus

- **J-PLUS**: auxiliary telescope w large FoV to identify and classify millions of (secondary standard) stars for J-PAS calibration
  - T80Cam on JAST/T80 (83cm), F#4.5
J-PLUS OVERVIEW
Goals and Survey Strategy
Valencia, Feb 25 – Mar 1, 2013
Javier Cenarro
Calibration Strategy

Secondary Standard Star

J-PLUS → Observed SED → Stellar Spectral Fitting → Best Stellar Model

J-PAS

Stellar Model SED × JPAS FS =

m_{\text{synth}}_{\lambda}
Central Wavelength shift across FoV

• J-PAS (4.7sqdeg) with a mosaic of 14 CCD units, each with 1 filter
• The maximum shift is 0.2% of CW.
• By combining an optimal dithering of 4 exposures, the net CW shift can be further reduced to well below 0.3% photoz requirement.
• J-PAS will keep track of the position of each object wrt the filter to reconstruct the effective transmission shape if necessary for some applications.
Synergy with Intensity Mapping (z=1-3)?

**Lyman-α emitters** (LAEs, 1216Å Lyα)
- Massively-star-forming galaxies (z>0.8) as a tracer of CO?
- Ground-based LAE search only above z~1.6

J-PAS will detect bright LAEs at 2<z<5 (z~1 LAEs by J-PAS+Galex)

**J-PAS filter system optimized for 2<z<2.4 LAE search**
- J-PAS Survey: n = 7 +/- 2 LAEs/sqdeg (i < 23ABmag)
- J-PAS Deep Survey: n = 37 +/- 4 LAEs/sqdeg (i<24 ABmag)

with a rest-frame EW(Lyα) > 35Å (filters@360, 379, 390, 400nm).

Additionally J-PAS will generate a large # of candidates for extremely-bright, compact Ly-α blobs (Lα=1e44-45erg/s, z~2-4).
TIMELINE

Q2 2014:
  T250 delivery & on-site integration (Happening)

Q4 2014:
  T250 Commissioning start

Q2 2015:
  JPCAM delivery by E2V

Q3 2015:
  JPAS-Pathfinder Survey, 0.35sq.deg camera

Q4 2015:
  Main survey starts

Figure 52: The OAJ main telescopes: JST/T250 at the integration

BENITEZ ET AL 2014, arXiv:1403.5237

www.j-pas.org
Supplemental Slides
J-PAS: Limiting Magnitudes

Figure 3: Limiting AB magnitudes ($5\sigma$, 3 arcsec aperture) for all the filters in the survey, color coded by their tray distribution

# JPCam Spec

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>FoV</td>
<td>$\theta = 1.7^\circ$</td>
</tr>
<tr>
<td>EE50</td>
<td>$\theta = 11\mu m$</td>
</tr>
<tr>
<td>EE80</td>
<td>$\theta = 22\mu m$</td>
</tr>
<tr>
<td>CCD format</td>
<td>Science (14X) $9.216k \times 9.232k$pix$^2$, $10\mu m$/pix</td>
</tr>
<tr>
<td></td>
<td>Guiding (4X) $1.024k \times 1.024k$pix$^2$, $13\mu m$ (frame transfer)</td>
</tr>
<tr>
<td></td>
<td>Wavefront sensing (8X) $2.048k \times 2.048k$pix$^2$, $15\mu m$ (frame transfer)</td>
</tr>
<tr>
<td>Pixel scale</td>
<td>0.2267$/$/pix</td>
</tr>
<tr>
<td>FoV coverage</td>
<td>$4.7^\circ$ (fill factor 65%)</td>
</tr>
<tr>
<td>Read out time</td>
<td>12s</td>
</tr>
<tr>
<td>Read out noise</td>
<td>$4e^-$/pixel (goal)</td>
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<tr>
<td>Full well</td>
<td>$130ke^-$</td>
</tr>
<tr>
<td>CTE</td>
<td>0.99995</td>
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<tr>
<td>Dark current</td>
<td>$0.0006e^-$/pixel $s^{-1}$</td>
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<tr>
<td>Number of filters</td>
<td>70</td>
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Table 24: JPCam parameters
J-PAS Intermediate/Broad-band Filters

<table>
<thead>
<tr>
<th>Filter</th>
<th>$\lambda_c$</th>
<th>FWHM(Å)</th>
<th>$m^5\sigma_{AB}(3''\odot)$</th>
<th>$m^5\sigma_{AB}(/\square''\odot)$</th>
<th>$t_{exp}(s)$</th>
<th>Tray</th>
</tr>
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<tbody>
<tr>
<td>J-PAS3518</td>
<td>3596</td>
<td>261</td>
<td>22.66</td>
<td>23.73</td>
<td>240</td>
<td>T1</td>
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<tr>
<td>$u_{J-PAS}$</td>
<td>3856</td>
<td>357</td>
<td>23.10</td>
<td>24.16</td>
<td>225</td>
<td>T5</td>
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<tr>
<td>$g_{J-PAS}$</td>
<td>4931</td>
<td>1441</td>
<td>23.75</td>
<td>24.81</td>
<td>225</td>
<td>T5</td>
</tr>
<tr>
<td>$r_{J-PAS}$</td>
<td>6301</td>
<td>1189</td>
<td>23.93</td>
<td>24.99</td>
<td>600</td>
<td>T5</td>
</tr>
<tr>
<td>J-PAS10069</td>
<td>9505</td>
<td>618</td>
<td>21.51</td>
<td>22.57</td>
<td>480</td>
<td>T4</td>
</tr>
</tbody>
</table>

Table 5: J-PAS Medium and Broad band observations. The central wavelengths $\lambda_c$ and filter widths (FWHM) have been calculated taking into account the expected E2V CCD Quantum Efficiency and the Javalambre expected atmosphere at 1.2 airmasses. We also list the $5-\sigma$ detection magnitudes in a 3'' diameter aperture and per $''^2$.  

J-PAS: Telescope JST/T250

Figure 58: The OAJ main telescopes: JST/T250 at the integration hall in AMOS headquarters (left) and JAST/T80 at the OAJ (right).
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FIRST STAGE IV experiment, starting around 2015

~ 100M galaxies with 0.3% photo-z > LSS

~ 300M galaxies with 1% photo-z > Cluster counting, 3D lensing tomography

~ 400-500M galaxies with 3% photo-z, Cosmic Shear

~ few M QSOs with 0.3% photo-z > Measure w all the way to z=3

~ 0.7 arcsec image of the Northern Sky

- Extremely mass sensitive optical cluster catalog
- Excellent characterization of low-z SN systematics
- 6000 SNle survey, no spectroscopy required
- Pixel-by-pixel low-res spectrum of the whole northern sky up to m~23/arcsec^2

Unique, fundamental dataset for many Astrophysical areas

BENITEZ ET AL 2014, arXiv:1403.5237

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