FUTURE GROUND-BASED SPECTROSCOPIC SURVEYS

Olivier Le Fèvre, Laboratoire d’Astrophysique de Marseille

Ground-based heritage
Existing and planned ground-based facilities
Is ground competitive with space?
EUCLID-NIS has a ground-based heritage: MOS

- Multi-object spectroscopy is a mature technology on most major ground-based telescopes
- It allows a very high survey efficiency
  - At low redshifts $z<1$: multi-fiber
  - At high redshifts $z>1$: multi-slit
The power of MOS

- Get spectra of many objects over a large field of view
- For cosmology:
  - Get redshifts AND spectral properties
  - 3D mapping of large scale structures
Existing redshift surveys relevant to DE

2DFGRS

SDSS

BAO from Low-z SDSS

Growth rate to $z \approx 1$ from galaxy distribution in VVDS (VLT-VIMOS)

Guzzo et al., 2008
On-going surveys

- SDSSIII – Boss: 1 million z, z~0.6
- VIMOS-VIPERS: 100,000 z, z~0.8-1
- Wiggle-z

VIPERS: VLT-VIMOS
100,000 spectroscopic z
~450 h of VLT time

2x8 deg² slice in CFHTLS W1 field

+2x4 deg² slice in CFHTLS W4 field (VVDS F22)
Ground-based surveys: competitive with EUCLID-NIS?

Key parameters:

- Sensitivity: tel. diameter, background, throughput
- Wavelength range $\rightarrow$ redshift range
- Field of view
- Multiplex: number of simultaneous spectra
- Number of effective hours (integrating) available
# Existing facilities

<table>
<thead>
<tr>
<th>Telescope</th>
<th>Diameter / Field</th>
<th>Wavelength / # objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLT-VIMOS</td>
<td>8m / 0.06deg²</td>
<td>0.37-1 μm / 800</td>
</tr>
<tr>
<td>VLT-FLAMES</td>
<td>8m / 0.2deg²</td>
<td>0.4-0.9 μm / 100</td>
</tr>
<tr>
<td>SDSS-3</td>
<td>2.5m / 2.5deg²</td>
<td>0.36-1 μm / 1000</td>
</tr>
<tr>
<td>Keck-DEIMOS</td>
<td>10m / 0.03deg²</td>
<td>0.4-1 μm / 120</td>
</tr>
<tr>
<td>Magellan-IMACS</td>
<td>6.5m / 0.12deg²</td>
<td>0.37-1 μm / 1000</td>
</tr>
<tr>
<td>FMOS-Subaru</td>
<td>8m / 0.1 deg²</td>
<td>1-1.8 μm / 100</td>
</tr>
</tbody>
</table>

# Planned facilities

<table>
<thead>
<tr>
<th>Telescope</th>
<th>Diameter / Field</th>
<th>Wavelength / # objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLT-VIMOS upgrade</td>
<td>8m / 0.06deg²</td>
<td>Gain x2 in efficiency</td>
</tr>
<tr>
<td>VLT-new FLAMES</td>
<td>8m / 0.2deg²</td>
<td>0.4-1.2 μm / 500</td>
</tr>
<tr>
<td>WFMOS-? (Subaru ?)</td>
<td>8m / 1.2deg²</td>
<td>0.36-1 μm / 3000</td>
</tr>
<tr>
<td>BigBoss</td>
<td>4m / 5deg²</td>
<td>0.34-1.13 μm / 5000</td>
</tr>
<tr>
<td>XMS</td>
<td>3.6m/1deg²</td>
<td>0.4-0.92 μm / 4000</td>
</tr>
<tr>
<td>LBT</td>
<td>8m/5deg²</td>
<td>0.37-1 μm / 5000</td>
</tr>
<tr>
<td>JWST</td>
<td>6.5m/0.0025deg²</td>
<td>1-5 μm / 100</td>
</tr>
<tr>
<td>TMT</td>
<td>30m / 0.03 deg²</td>
<td>0.37-1.6 μm / 400</td>
</tr>
<tr>
<td>EELT</td>
<td>42m / 0.015 deg²</td>
<td>0.37-1.6 μm / 400</td>
</tr>
</tbody>
</table>
Proposed ground-based survey instruments: best contenders

- **WFMOS**
  - On an 8m, 1.2deg², >3000 fibers, not funded

- **XMS**
  - On a 4m (CAHA), 1deg², >4000 slits, not funded

- **Big Boss**

Other being discussed/studied:
- 5 deg² multi-slit spectrograph on LBT
- ?
Big Boss, the instrument

- 4m telescope,
- KPNO for 5 years
- then CTIO for 5 years
- FOV: 5 deg$^2$
- 5000 fibers
- 0.34-1.13 microns
Big Boss, the proposed survey

- 24,000 deg²: 14,000 on the KPNO 4m, 10,000 on CTIO
- 10 years survey
  - 180 nights, 50% efficiency, 8h/night = 7200h total
- Targets
  - LRGs 0.2<z<1
  - Star forming galaxies: [OII]3727Å, 0.7<z<2
    - Efficiency of pre-selection TBD
  - QSOs: 2<z<3.5
- Input imaging: Griz Pan-Starrs, u CFHT
- 45 million galaxies, 1 million QSOs
Big Boss, realistic performances vs. ENIS

- Critical review of assumptions on BigBoss
- Vary key parameters from pessimistic to optimistic (spreadsheet)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Big Boss</th>
<th>ENIS slitless</th>
<th>ENIS DMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total field</td>
<td>13,000 to 16,000</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Duration</td>
<td>10y</td>
<td>5y</td>
<td>5y</td>
</tr>
<tr>
<td>Redshift range (galaxies)</td>
<td>0.7-2 ([OII])</td>
<td>0.5-2 (Hα)</td>
<td>0.5-2 (Hα) Up to z~4 ([OII])</td>
</tr>
<tr>
<td>Depth erg.s⁻¹.cm⁻² (7 σ, 1.6 microns)</td>
<td>2.5x10⁻¹⁷</td>
<td>4x10⁻¹⁶</td>
<td>1x10⁻¹⁸</td>
</tr>
<tr>
<td>Resolution</td>
<td>2000</td>
<td>500</td>
<td>200-400</td>
</tr>
<tr>
<td>Number of galaxies</td>
<td>15 million (pessimistic) 45 million (optimistic)</td>
<td>70 million</td>
<td>200 million</td>
</tr>
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</table>
Conclusion

- Main limitation from ground: sky background
- Ground based spectroscopic surveys will not reach the performances of space, even after 10 years
  - They will be an intermediate step towards the best space experiments
  - Should not oppose ground and space experiments, both are needed
- ENIS = 3 to 10x more galaxy redshifts than best ground experiments, with larger redshift coverage
- DMD spectroscopy offers the best « safety margin »