

ALFALFA

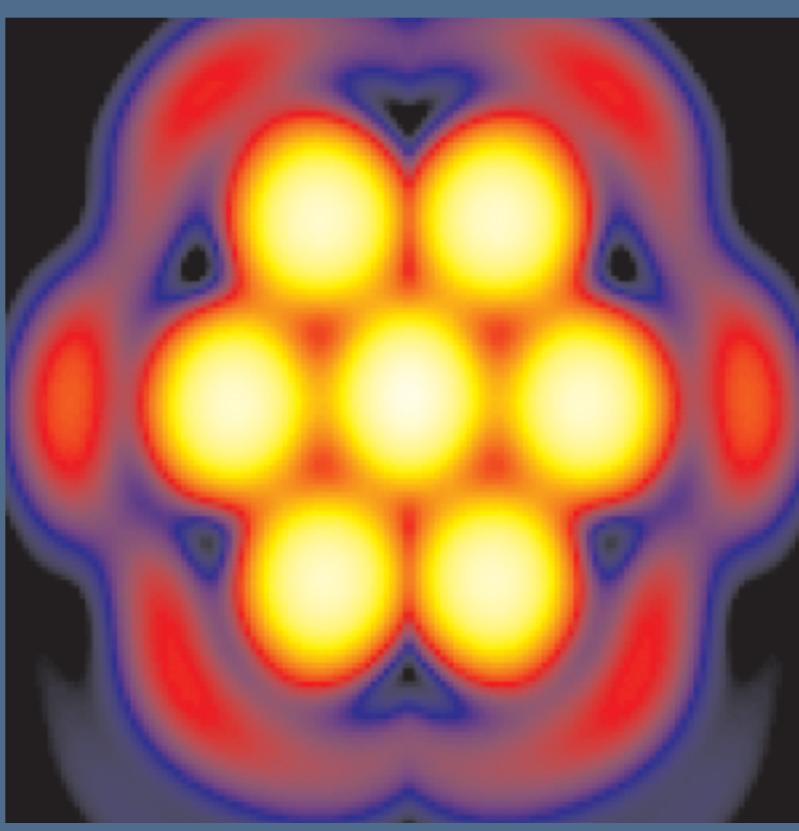


A SIGNAL EXTRACTION UTILITY FOR THE ALFALFA SURVEY

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ALFALFA : A SURVEY OF EXTRAGALACTIC HI WITH THE ALFA MULTI-BEAM SYSTEM AT ARECIBO

Sky area that will be covered	7074 deg ²
Declination range	0° - 36°
Right Ascension range	07h30m-16h30m, 22h00m-03h00m
Frequency range	1335 - 1435 MHz
Velocity range	-1600 to 18000 km s ⁻¹
Observing mode	Fixed azimuth drift scan
Number of passes	2
Integration time per beam	48 seconds
Telescope time required	4130 hours



The signal extraction utility consists of:

- a **computation module** that works on individual position-velocity maps or on 3-D data cubes
- an **interactive display** to allow the user to view the results of the search
- a final **catalog** containing the detections made above the requested S/N threshold

The catalog contains for each galaxy: a centroid position, a redshift, a velocity width, scale lengths for both spatial directions, peak and integrated fluxes, rms noise and S/N ratio.

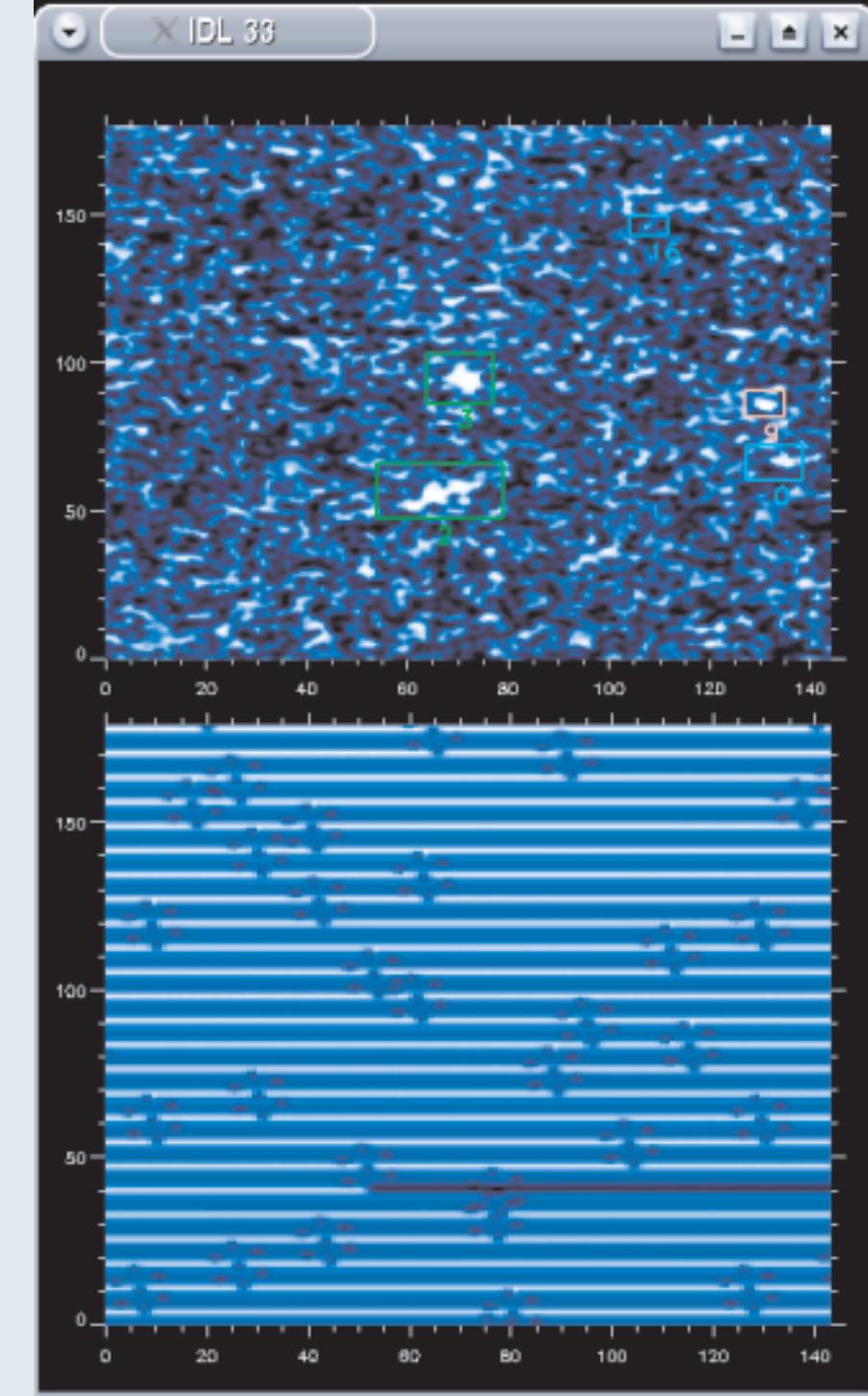


FIG 3. Example of the interactive display unit. The top panel is a slice of the data cube showing the RA-DEC plane at a constant velocity, and the bottom panel is the survey coverage over the same area.

A VERY LOW SURFACE BRIGHTNESS GALAXY

No optical counterpart down to the surface brightness limit of the DSS2 blue.

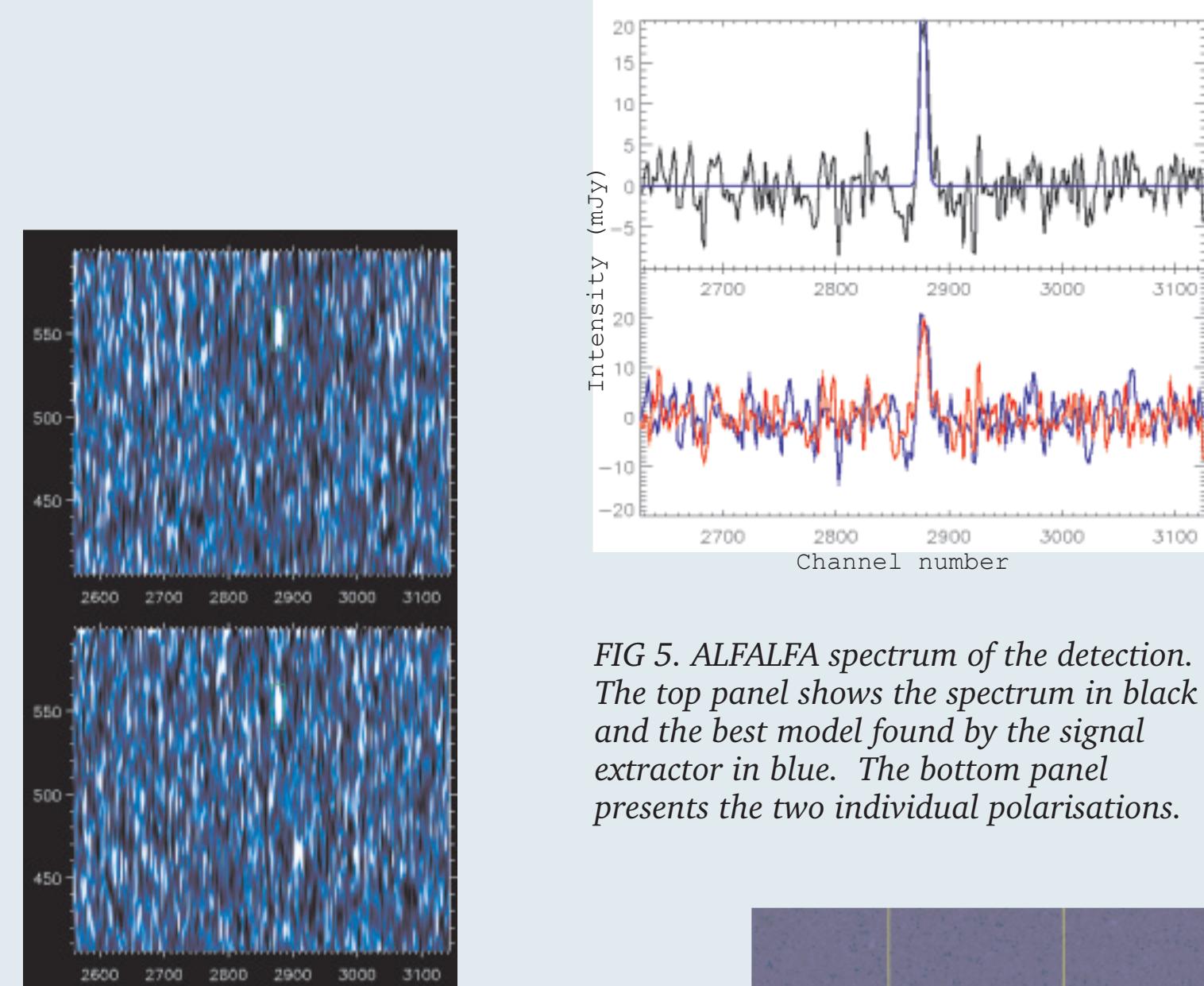


FIG 4. Position-velocity map showing the detection in channel 2880 (cz=3264 km s⁻¹) for both polarisations. The green box shows the extent of the galaxy as determined by the signal extractor.

cz=3264 km s⁻¹

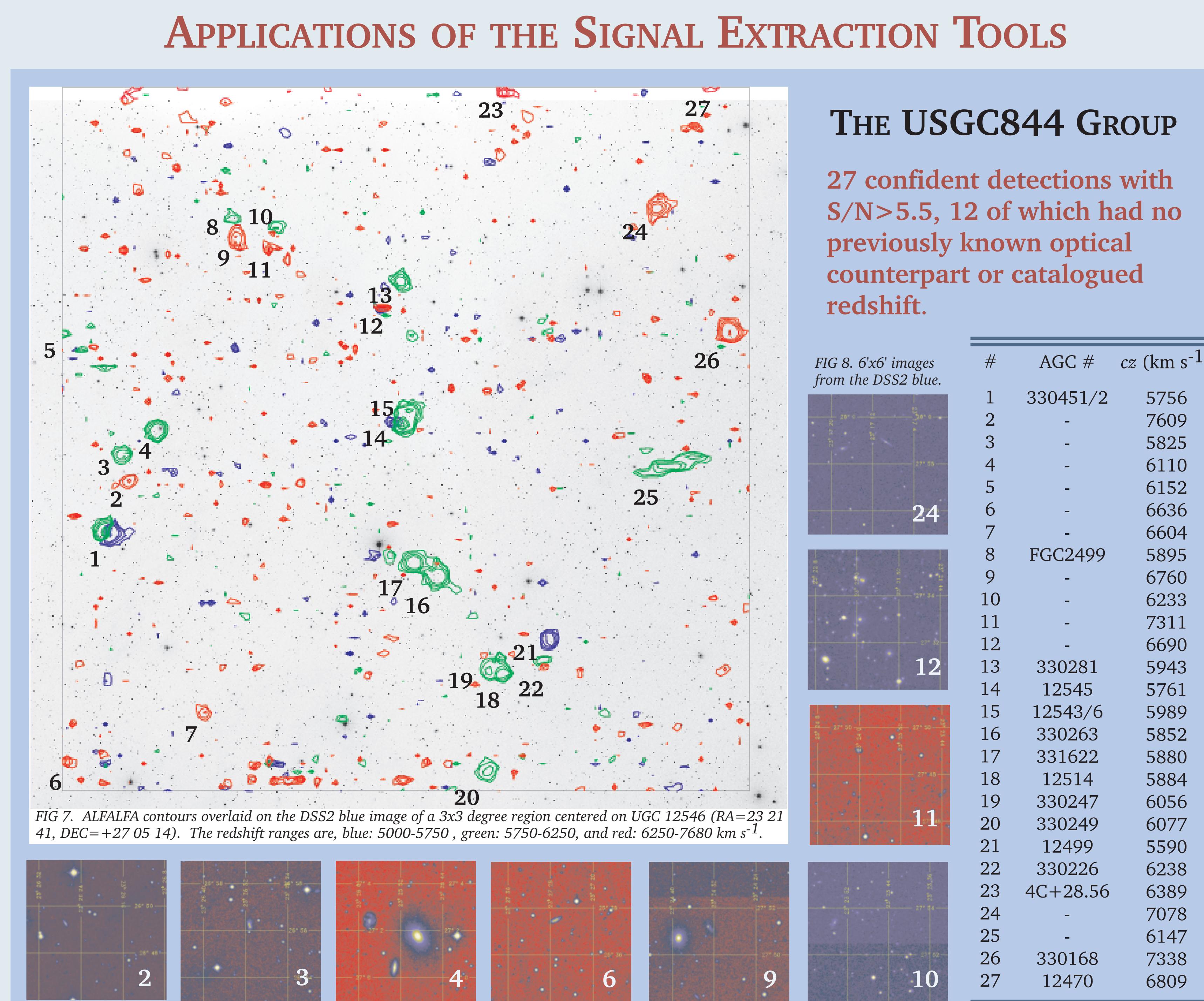
F_{peak}=20 mJy

W=37 km s⁻¹

M_{HI}=3.7x10⁸ M_⊙ *

M_{dyn}=4.2x10⁹ (r/1') M_⊙ *

* assuming that the source is not resolved by the 3.5' beam of ALFA



THE NGC 672 GROUP

Three galaxies with M_{HI}<10⁷ M_⊙, one previously unknown.

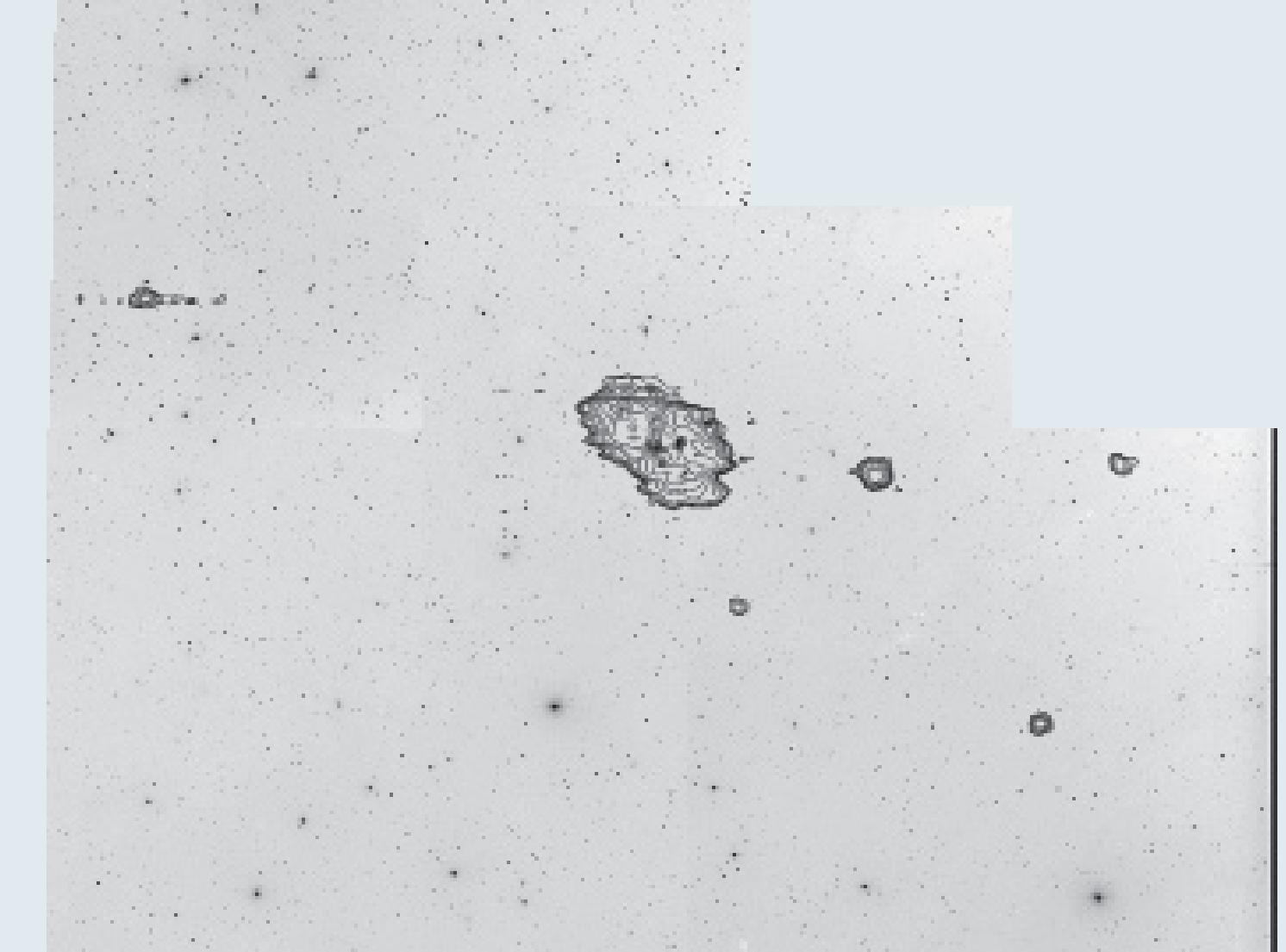


FIG 9. ALFALFA detections in a 4 x 3.5 degree region centered on NGC 672 / IC 1727 with velocities between 100 and 600 km s⁻¹. The optical image is from the Digitized Sky Survey.

AGC #	RA (J2000)	DEC (J2000)	cz (km s ⁻¹)	log(M _{HI} /M _⊙) *
112521	01 41 05.0	+27 19 00	278	6.77
110482	01 42 15.0	+26 21 00	366	7.13
111945	01 44 42.8	+27 17 19	428	7.66
111946	01 46 40.0	+26 48 00	371	6.95
1249 (NGC 672)	01 47 29.9	+27 20 00	345	8.82
1256 (IC 1727)	01 47 54.5	+27 25 58	422	9.05
111977	01 55 15.0	+27 57 00	210	6.75

* HI masses from Giovanelli et al. 2005, AJ, 130, 2613

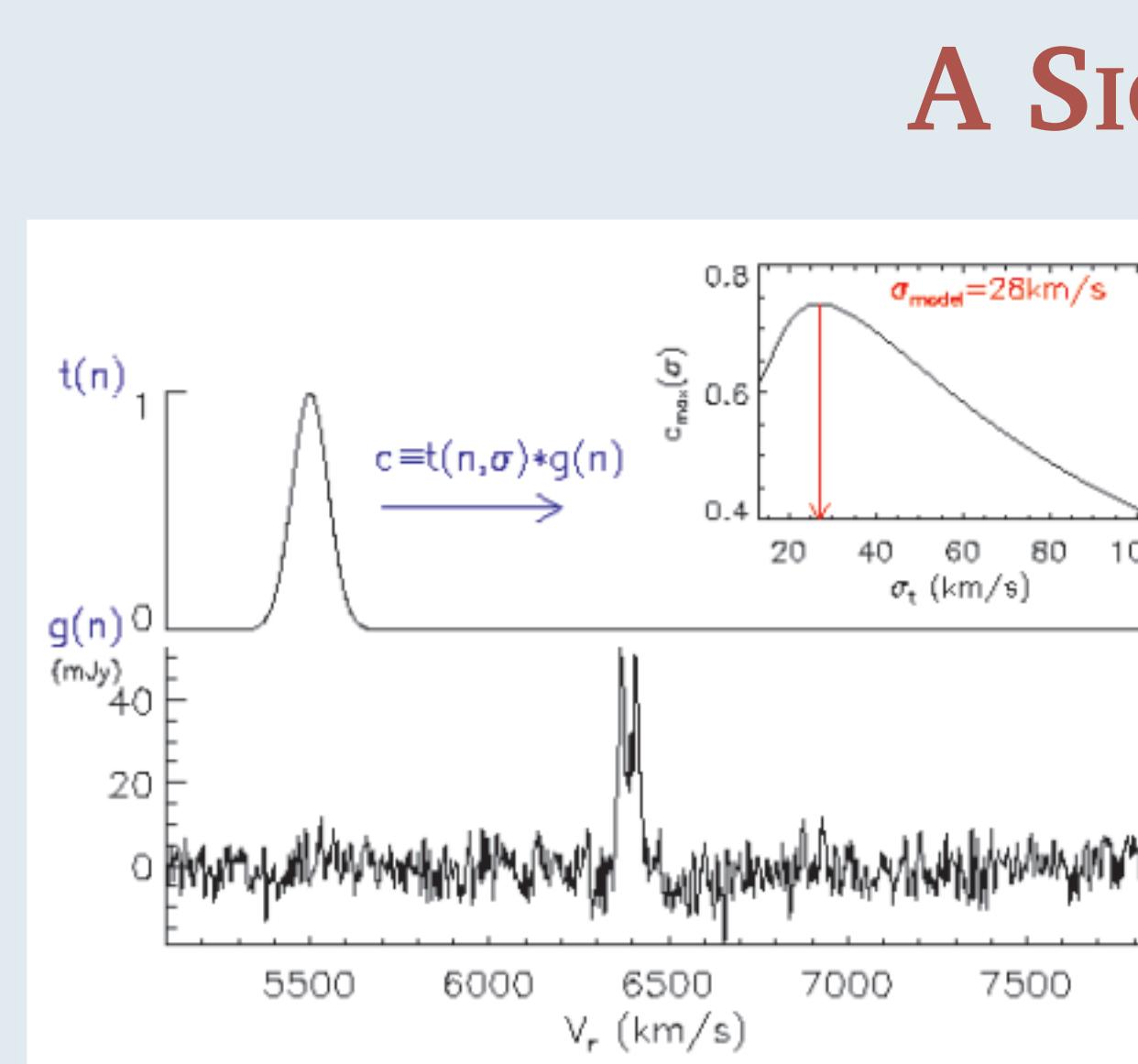


FIG 1. Overview of the matched filtering approach. Gaussian templates of various widths, $t(n)$, are convolved with the spectra, $g(n)$, in the Fourier space. The template that maximises the convolution is the modeled galaxy signal.

A SIGNAL EXTRACTION UTILITY

OVERVIEW

- A **matched filtering** approach
- Matching **Gaussian templates** with the spectra
- Calculations done in **Fourier space**
- Detections from individual spectra are combined
- **3-D models** of the detected galaxies are made

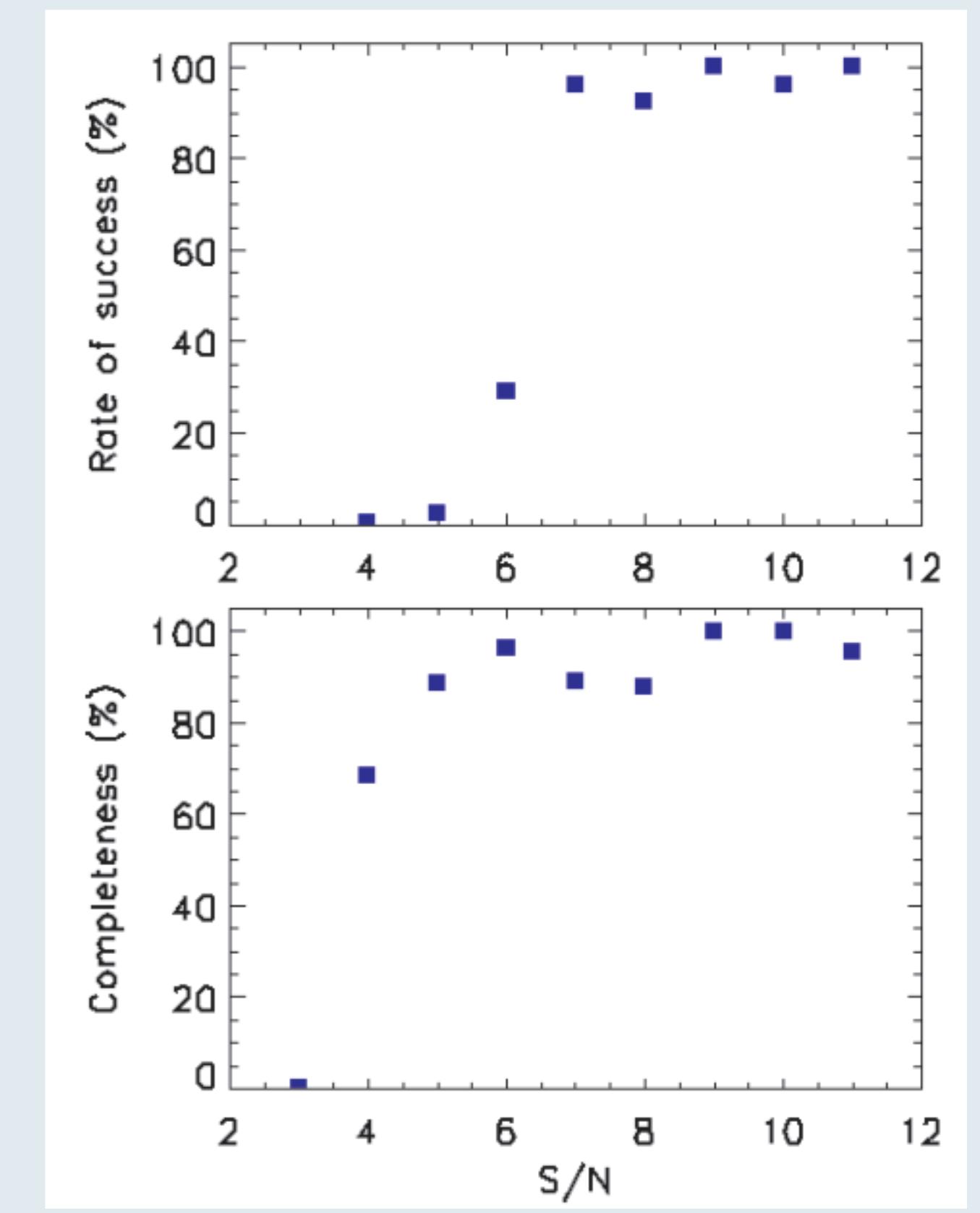


FIG 2. Reliability and Completeness of the signal extraction tool, based on the simulation of 400 galaxies. The top panel is the fraction of detections made as a function of S/N that are good. The bottom panel is the fraction of simulated galaxies that are retrieved as a function of S/N.

PERFORMANCE

The matched filtering approach and the Fourier space calculations make this signal extraction tool:

- **quick** to perform the calculations and more **robust** and consistent than "human" extraction
- **sensitive** to the *total flux* of the galaxy rather than just the peak flux

We have adopted the following definition for the signal-to-noise ratio

$$S/N = \begin{cases} F_{\text{peak}} \left(\frac{W}{2 \text{res}} \right)^{1/2} & \text{if } W < 200 \text{ km s}^{-1} \\ F_{\text{peak}} \left(\frac{200}{2 \text{res}} \right)^{1/2} & \text{if } W \geq 200 \text{ km s}^{-1} \end{cases}$$

where res is the spectral resolution in km s⁻¹.

so for instance, a 50 km s⁻¹ wide feature with a peak flux to noise ratio of 3.5 will here have S/N=5.5