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NFRA
ASTRON

APPLICATION FOR OBSERVING TIME AT WESTERBORK

SEMESTER: **02A**

(Please read the instructions before filling in the form)

Figures: 3

1. Name of principal investigator and mailing address

F.H. Briggs
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2. Co-investigators (name & institute code & email)

E. Tolstoy (RuG, etolstoy@astro.rug.nl)

3. Short title (10 words maximum) of proposed programme

Dimmest HI Dwarf Galaxies

4. Abstract (Concise summary of the proposal)

WSRT observations of two of the dimmest, HI-selected dwarf galaxies SS47 and SS73 will provide reliable coordinates, as well as a first look at their sizes and kinematical structure. The observations will complement our imaging program with Gemini-North. The ultimate goal is to increase the confidence in the meaurements of space density for these illusive LSB galaxies.

5. **Total** number of hours requested this semester, **including** calibration:

26

6. Indicate special scheduling requirements (e.g. splitting of observing time, telescope sequence)

7. Indicate whether the investigators will be present at Westerbork at the time of the observations

☐ Yes ☒ No

8. For **long term** projects it is **mandatory** to indicate here the number of hours of observing time awarded in previous semesters for this project and the numbers of hours to be requested in future semesters

a) hours awarded in previous semesters	b) hours requested this semester	c) hours to be requested in future semesters
0	26	0

9. Level of support

☐ None ☒ Consultation ☐ Extensive Help

10. Summary of required instrumentation

Proposal can be implemented with minimal DZB spectrometer capability: 2 polarizations with 128 channels, Hanning smoothing, and 1.25 MHz bandwidth. If a greater number of channels or multiple crates of DZB are available, then higher spectral resolution and wider coverage will be used.

11. Report on the last observations conducted at Westerbork

A) Proposal number:

B) Observing dates: 15-April-2001

C) Results:
Paper in press, A&A: "Did VV 29 collide with a dark Dark-Matter halo? "

12. Applicant's publications related to the *subject* of this application during the past two years

13. If this programme is for thesis work, indicate:

– The name of the student:

– Name of Supervisor:

– The status of the work: ☐ Starting ☐ In mid-course ☐ Near completion

– Are the data required for completion of the thesis: ☐ Yes ☐ No

14. Special remarks

15. Scientific justification of the proposed programme (only figures and tables will be accepted as attachments). (1 page, continue in box 15 if necessary)

The nature and number density of the lowest mass galaxies is controversial, and astronomers have been unable to reach agreement on the faint ends of either the optical luminosity function or the HI mass function (HiMF). In fact, many believe that dim, gas-rich galaxies may dominate the neutral gas content of the Universe, forming a reservoir of gas-rich building blocks for ongoing accretion and continued star formation in large disk galaxies.

To address the nature of these objects, we are studying three extreme examples (see Fig. 1) of tiny HI-selected objects from an Arecibo blind 21cm survey by Spitzak and Schneider 1998. In Schneider etals' (1998) analysis of their sample of 75 galaxies, these three objects are responsible for the divergent tail of the HiMF in Fig. 2.

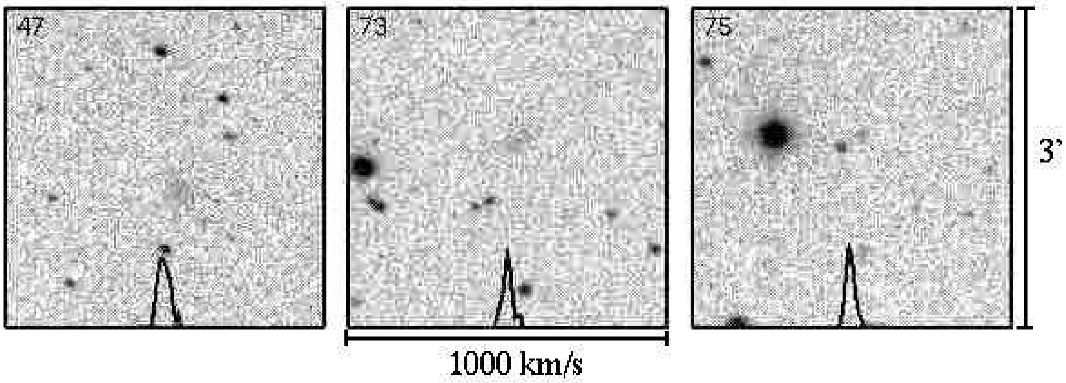

Figure 1. Optical images and HI spectra for 3 of the dimmest HI selected galaxies, SS47, SS73 and SS75 (Spitzak & Schneider 1998). Panels are $3' \times 3'$, with the spectra drawn on a velocity scale spanning 1000 km s^{-1}. Heliocentric velocities are 563, 469 and 411 km s^{-1}; velocity widths at 20% of maximum are 66, 53 and 51 km s^{-1}; and HI masses are 3.9, 1.5 and $0.7 \times 10^7 M_\odot$ respectively.

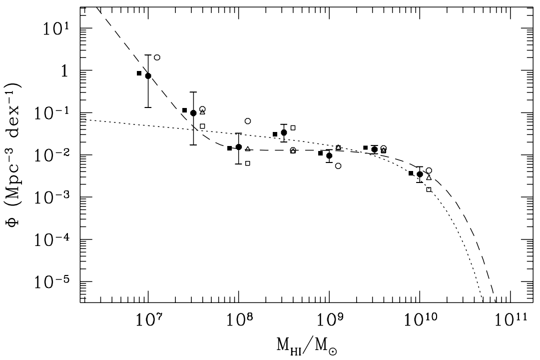

Figure 2. The HI Mass Function of Schneider, Spitzak & Rosenberg 1998). The abrupt kink upward at the lowest masses is due entirely to the three galaxies shown in Fig. 1.

We have been awarded time with Gemini-North to image two of the objects this fall (SS47 and SS73). The third object is too close to a bright star for useful optical imaging (See Fig 3, next page). The goal of the Gemini observations to assess the stellar populations and resolve the tip of the giant branch, thereby obtaining an independent distance determination.

Accurate distances for the objects are crucial in determining the HiMF for these objects, since both the mass bin that the objects fall into and the 'volume correction factors' used for computing number densities depend steeply on their distances. In blind surveys, these lowest masses can only be detected at small distances, making the use of Hubble flow velocities vulnerable to peculiar velocity offsets.

In fact, these objects fall well off the Tully-Fisher relation when Hubble distances are used. If the Hubble distances are true, SS47 and SS73 are not only extreme in HI to optically luminosity ratio (M_{HI}/L from 5 to 8), but also extreme in Dark Matter to baryonic mass ratio. If nudged to greater distance so that they agree with the T-F relation of other samples of dim, late-type galaxies, the divergent tail of the HiMF in Fig.2 disappears, since the galaxies would then have greater HI mass and also smaller volume correction factors. Either way, they are fascinating objects in their own right.

The Goals of these Proposed WSRT Observations are to refine the positions of these objects and make a rough determination of their angular size and kinematics. These measurements are necessary to the interpretation of the optical imaging (with a 5 arcmin field).

16. Technical requirements for the proposed programme (1 page).
(Continue scientific justification here if necessary)

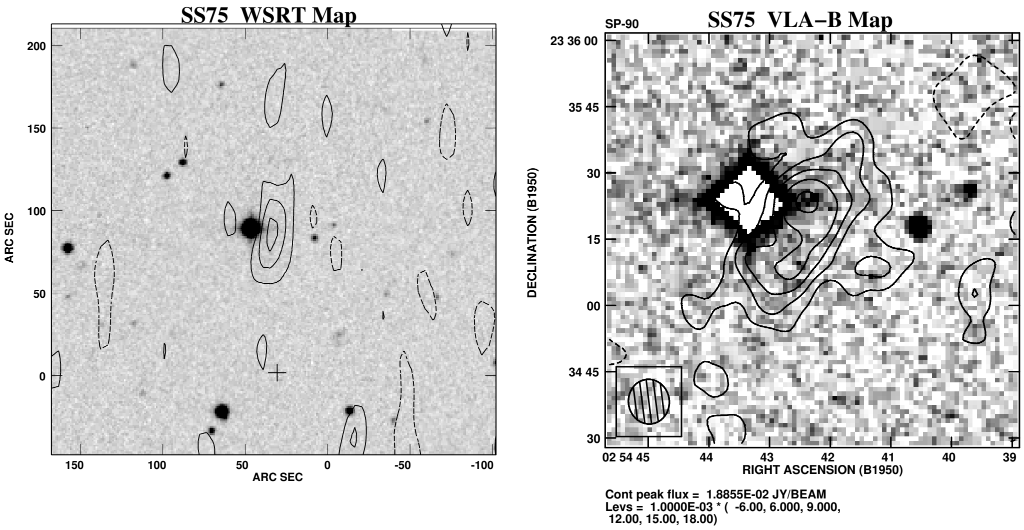

Figure 3. SS 75: Preliminary WSRT map (left) with + marking original Arecibo position, and VLA B-array map (right) (from Briggs and de Bruyn 'unpublished archives'). The WSRT map shown here is the first map made during the science commissioning of the DZB spectrometer, and it was adequate to demonstrate the Arecibo coordinates are in error by more than an arcminute; the true position is so close to a 12th magnitude star that an LSB galaxy would not be identifiable in most optical images.

The science goals can be met with one 12 hour observation of each galaxy SS47 and SS73. Since the objects are at declination 23°, the WSRT beam is elongated ($13'' \times 33''$), and the full u-v coverage is needed to maximize the north-south resolution. With spectral coverage of 1.25 MHz ($\sim$250 km s^{-1}) at velocity resolution $\sim$4 km s^{-1} after hanning smoothing, the observations will reach noise levels of $\sim$0.5 mJy/beam/channel (depending a little on taper), while the peak flux densities in the single dish spectra are $\sim$25 mJy. Therefore, we expect to have ample signal-to-noise ratio to resolve the objects, as would occur if they have structure in the east-west direction. The column density sensitivity will be $\sim 10^{19}$H-atom cm^{-2}, allowing for the detection of faint extended HI at column densities well below the star formation threshold and below the nominal "Damped Lyman-α" limit. These objects therefore will add to the sample available for evaluating interception cross sections for comparison with QSO absorption line studies, at column densities corresponding to the upper end of the "Lyman limit" QSO absorption line class.

If the Nominal DZB capability is available at the time of the observation, we will expand the velocity coverage and increase the spectral resolution over that available with only one IF of the DZB (as we have assumed above).

In addition to the 12hours requested per galaxy, we have allocated one hour per object for gain and passband calibration.

References

Schneider, S.E., & Spitzak, J.G., & Rosenberg, J.I. 1998, ApJ, 507, 9.
Spitzak, J.G. & Schneider, S.E. 1998, ApJS, 119, 159.
Zwaan, M., Briggs, F.H., Sprayberry, D., & Sorar, E. 1997, ApJ, 490, 173

17. List of sources proposed in this programme:

OBJECT	α h:m:s.s	δ ±d:m:s.s	EPOCH	HA_start ±h:m:s	HA_end ±h:m:s	FREQ Mhz	Vel. or z km/s	SPACING 9A[,9B,9C,9D] meters
SS47	01:33:51.3	23:33:56	1950	-6:0:0	6:0:0	1417.74	0.001878	Not Critical
SS73	02:45:46.7	23:03:45	1950	-6:0:0	6:0:0	1418.19	0.001564	"

18. Line Transition Specifications:

- Frequency: Line Transition: HI21cm — Rest Frequency: 1420.4057 MHz
- Velocity: Definition: opt — Reference: hel

19. Observation mode: Line
DZB

Observation parameters:

- waveband = 21
- number of polarizations = 2
- backend used = DZB
- number of channels = 128
- bandwidth = 1.25 MHz
- frequency taper = Hanning
- number of bits = 2
- sample integration time = 20 seconds

20. Output Specifications:

- Data format: UVFITS
- Data medium: CDROM