The knotty structure of the HII dwarf galaxy F348

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[OIII] images and blue spectra of the emission-line dwarf galaxy F348 are presented. In [OIII] light, the object contains two knots about $9''$ NE of the nucleus and one large extended knot $11''$ to the SW. The nuclear region is hundred times less luminous in emission-line light than the knots. Despite the presence of line intensity ratios $[\text{OIII}]\lambda 5007/\text{H}\beta > 3$ the prior classification as a Seyfert-2 object cannot be upheld. This clinches an earlier suggestion by Veron-Cetty & Veron (1986). In particular, we show that the line spectra can be modeled with photoionization models employing *stellar* input continua. Also, the line luminosities of the extranuclear knots are typical for giant HII regions. There is neither evidence for tidal tails nor for high velocity differences between the knots. In addition, the linear arrangement of the knots does not support interaction. It rather suggests self-propagating star formation. In this picture, the faintness of the nuclear region can be understood by an edge-on view. In addition, the nuclear starburst appears to be fading in contrast to the young extranuclear star formation regions. Within the scheme of Melnick (1987), F348 has to be classified as a multiple-system HII galaxy.

Key words: Galaxies: general – active galaxies – dwarf galaxies – galaxy nuclei – starburst galaxies – F348

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1. Introduction

F348 (ESO 234-IG56) was described for the first time by Arp (1980) in a paper pointing out the importance of the study of small, nearby ($z \sim 0.009$) galaxies in the context of galaxy formation and evolution. On UK-Schmidt prints the object consists of three lumps in a row. On Arp's 4-meter $\text{H}\alpha$ -plate the lumps are resolved into a rather compact pair of emission-line knots on one end, a more extended ionized region on the other end and a fainter diffuse emission-line region in the center.

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Based on apparent emission-line widths $\geq 500 \text{ km s}^{-1}$ and a ratio $[\text{OIII}]\lambda 4959/\text{H}\beta \geq 2$ the galaxy was classified as a Seyfert-2 by Fairall (1981). This classification was called in question by Veron-Cetty & Veron (1986) who had obtained one spectrum of F348 that is typical of a high-excitation HII region instead.

However, the given information on aperture sizes and pointing for the above mentioned spectrum is incomplete. Since the object contains several bright extranuclear spots and a dimmer nuclear region a more detailed study is required.

In the present work we present narrow-band interference filter images centered on $[\text{OIII}]\lambda 5007$ as well as blue spectra taken with the slit oriented along the major axis of the galaxy and along the NE double knot. Our goal is to present spectroscopic data for the individual emission line regions and to identify their excitation mechanisms in order to get clues for the nature of the activity in this dwarf galaxy.

2. Observations and data reductions

The data were collected with the ESO/MPIA 2.2m telescope at La Silla. Two spectra were taken in the nights Sep 4–5, 1985 and Oct 13–14, 1985, using the B&C spectrograph with a 600 lines/mm grating giving a mean dispersion of $85 \text{ \AA/mm}$ on the detector. On Sep 4 (exposure time 2700 sec) the slit was $1''.9$ wide, set along the direction joining the central region (hereafter C region) and the SW knot at $\text{PA} = 250^\circ$. On Oct 13 (exposure time 1800 sec) the slit was $2''.3$ wide with a $\text{PA} = 115^\circ$ and oriented along the two NE knots (see Fig. 1a). The spectra cover the range $\lambda 3400$ to $\lambda 5600$ with a typical resolution (FWHM of a faint comparison line) of $4 \text{ \AA}$. Both spectra were observed with the ESA-PCD (the groundbased version of the faint object camera on board of HST; cf. di Serego Alighieri et al. 1985) in the 1024×256 pixels configuration with a pixel size of 25μ and a scale factor of $1''.14$ per pixel.

The images were taken with a RCA CCD of 320×512 pixels, each 30μ square, at the RC focus of the telescope (scale of $0''.35$ per pixel). The ESO interference filters No. 370 (central wavelength $5056 \text{ \AA}$, band width $54 \text{ \AA}$) and No. 150 (central wavelength $5511 \text{ \AA}$, band width $252 \text{ \AA}$) were used.

All spectra were reduced using the VISTA image processing package developed at Lick Observatory and the spectra were measured with the RETICENT analysis program (Pritchett et al. 1982). The raw PCD spectra were corrected for S-distortion and then sky subtracted by using spectral rows unaffected by galactic light. For the flux calibration the standard star HZ 4 was used.

The PCD becomes nonlinear at high flux levels. This is the case for $[\text{OIII}]\lambda 5007$ in our spectra. Therefore, $[\text{OIII}]\lambda 5007$ flux values given below are scaled from $[\text{OIII}]\lambda 4959$ in proportion to the ratio of the transition probabilities given in Osterbrock (1989). The observed emission-line fluxes F_λ were corrected for galactic reddening using the extinction values given by Burstein and Heiles (1984) and the Whitford reddening law as parameterized by Miller and Mathews (1972). A further correction was made for internal reddening comparing the observed Balmer decrement with the theoretical case B decrement given in Osterbrock (1989) yielding the values denoted as I_λ in Tables 1 and 2.

Table 1. F 348: emission line intensities relative to $\text{H}\beta$; observed: F_λ ; reddening corrected: I_λ .

Table 1a SW knot ($\text{PA} = 250^\circ$)					Table 1b NEKNOT ($\text{PA} = 250^\circ$)					Table 1c Central region C ($\text{PA} = 250^\circ$)			
Line	λ	F_λ	I_λ	Model ⁽¹⁾	Line	λ	F_λ	I_λ		Line	λ	F_λ	
[OII]	3727	1.52	2.04	1.45	[OII]	3727	1.55	3.12		[OII]	3727	4.01	
[NeIII]	3869	0.46	0.59	0.32	[NeIII]	3869	0.26	0.48		$\text{H}\beta$	4861	1.00	
HeI	3889	0.16	0.21	0.07	HeI	3889	0.05	0.09		[OIII]	4959	1.32	
[NeIII]	3967	0.20	0.25	0.11	[NeIII]	3967	0.08	0.14		[OIII]	5007	5.02	
H_δ	4102	0.21	0.26	0.31	H_δ	4102	0.08	0.13		$F(\text{H}\beta) = 1.98 \cdot 10^{-16} \text{ erg cm}^{-2} \text{ s}^{-1}$			
H_γ	4340	0.41	0.47	0.51	H_γ	4340	0.33	0.47					
H_β	4861	1.00	1.00	1.00	H_β	4861	1.00	1.00					
[OIII]	4959	1.60	1.57	1.58	[OIII]	4959	1.13	1.08					
[OIII]	5007	4.73*	4.63*	4.67	[OIII]	5007	3.33	3.19					

$$F(\text{H}\beta) = 2.04 \cdot 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$I(\text{H}\beta) = 5.89 \cdot 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$c(\text{int}) = 0.45$$

⁽¹⁾ HII region model using a Kurucz stellar atmosphere model with $T_{\text{eff}} = 41000 \text{ K}$, as described in the text.

(*) calculated using $F([\text{OIII}]\lambda 5007) = 2.95 F([\text{OIII}]\lambda 4959)$

$$F(\text{H}\beta) = 6.72 \cdot 10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$I(\text{H}\beta) = 8.46 \cdot 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$c(\text{int}) = 1.09$$

Images were reduced (flatfield corrected, sky subtracted, aligned) using the MIDAS image processing package. The distribution of the $[\text{OIII}]\lambda 5007$ emitting regions was obtained subtracting from the image through filter 370 the image through filter 150, multiplied by a factor fixed in such a way that the foreground stars disappear in the resulting image.

3. Results

3.1. Morphology and systemic velocity

The extent of the galaxy along the major axis, as estimated from the continuum image Fig. 1b is about $31''$ ($3.99h^{-1}$ kpc); we use a scaled Hubble parameter $h = H_0/(100 \text{ km s}^{-1} \text{ Mpc}^{-1})$ which is in good agreement with the diameter of $0'.5$ given in Arp & Madore (1987). Along the minor axis the galaxy extends to about $16''$ ($2.06h^{-1}$ kpc). The two NE knots are separated by $3''.5$ ($450h^{-1}$ pc) and the distance between the SW and the NE2 knot is $20''.2$ ($2.69h^{-1}$ kpc).

The strikingly biconical structure of the high-excitation emission-line gas appears evident from Fig. 1c (pure $[\text{OIII}]$ emission). The positions of the slit are shown in Fig. 1a; none of the NE knots falls completely inside the slit pointed in Sep 4, 1985 at $\text{PA} = 250^\circ$. In this night the slit covered the region between the two NE knots (hereafter this region and its spectrum will be called NEKNOT). As is evident from Fig. 1c the central region C is also emitting lines albeit on a lower level (spectrum in Fig. 3).

The five spectra extracted are shown in Figs. 2 and 3 while the observed and extinction corrected line-intensity ratios relative to $\text{H}\beta$ and the absolute fluxes of $\text{H}\beta$ are given in Tables 1, 2.

Fig. 1. (a) image of $[\text{OIII}]$ plus continuum, (b) continuum, (c) pure $[\text{OIII}]$

Fig. 2. Spectra of individual knots

There seems to be no statistically significant difference among the heliocentric redshifts (all calculated by measuring the position of the centroid of the H β , H γ , H δ , [OIII] $\lambda\lambda$ 4959, 5007 and [NeIII] λ 3869 emission lines) of the three main knots of the galaxy (SW, NE1 and NE2), hence we take for the redshift of the whole galaxy the value of 0.0087 ± 0.0001 (weighted average of the value deduced from each spectrum) corresponding to a heliocentric radial velocity of $2600 \pm 40 \text{ km s}^{-1}$. The more uncertain value derived from the noisy spectrum of the C region using only H β and [OIII] $\lambda\lambda$ 4959, 5007 is consistent with this.

Table 2. F 348: Emission line intensities relative to H β ; observed: F_λ ; reddening corrected: I_λ .

Table 2a. NE1 Knot (PA = 115°)

Line	λ	F_λ	I_λ	Model I ⁽¹⁾	Model II ⁽²⁾
[OII]	3727	1.55	1.94	2.22	2.69
[NeIII]	3869	0.18	0.22	0.10	0.13
HeI	3889	0.06	0.07	0.08	0.06
[NeIII]	3967	0.06	0.07	0.03	0.04
H δ	4102	0.15	0.17	0.31	0.31
H γ	4340	0.42	0.47	0.51	0.51
[OIII]	4363	0.10:	0.11:	—	0.01
H β	4861	1.00	1.00	1.00	1.00
[OIII]	4959	0.75	0.74	0.82	1.08
[OIII]	5007	2.21	2.18	2.42	3.18

$$F(\text{H}\beta) = 6.99 \cdot 10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$I(\text{H}\beta) = 1.56 \cdot 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$c(\text{int}) = 0.34$$

(1) HII region model using a Kurucz stellar atmosphere model with $T_{\text{Kurucz}} = 41000 \text{ K}$ and an ionization parameter of $\log U = -1.75$, as described in the text.

(2) As model I, but with $T_{\text{Kurucz}} = 39.500 \text{ K}$ and $\log U = -0.75$.

Table 2b. NE2 Knot (PA = 115°)

Line	λ	F_λ	I_λ
[OII]	3727	1.06	1.71
[NeIII]	3869	0.15	0.23
HeI	3889	0.05	0.07
[NeIII]	3967	0.08	0.12
H δ	4102	0.16	0.22
H γ	4340	0.37	0.47
H β	4861	1.00	1.00
[OIII]	4959	1.28	1.24
[OIII]	5007	3.78	3.65

$$F(\text{H}\beta) = 6.40 \cdot 10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$I(\text{H}\beta) = 3.60 \cdot 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$$

$$c(\text{int}) = 0.74$$

Fig. 3. Spectrum of the nucleus

Fig. 4. BPT diagram showing the diagnostic line ratios of the individual knots and the central region C

3.2. Line ratios and excitation

Line intensity ratios for the major lines are shown in the classical diagnostic diagram $[\text{OIII}]\lambda 5007/\text{H}\beta$ vs. $[\text{OII}]\lambda 3727/[\text{OIII}]\lambda 5007$ (proposed by Baldwin, Phillips and Terlevich (1981); hereafter BPT) in Fig. 4.

All spectra are consistent with arising in HII type objects. However, line ratios from the SW and central region appear to be close to the AGN borderline. Since the classification borders in the BPT diagram are unsharp, we attempt a model approach in order to determine the dominant ionization mechanism in the line emitting regions. We have calculated a sequence of photoionization models using the code *Cloudy* (Ferland 1997).

In a first step, HII region models were studied with varying ionization parameter U (defined as $U = Q/(4\pi r^2 n_{\text{H}} c)$), where Q is the total rate of hydrogen ionizing photons, r is the distance between the ionizing photon source and the emission line clouds, n_{H} is the hydrogen density and c the speed of light. The ionizing source was described

by a single hot star, which has been found to be fairly representative of an ionizing star cluster as far as the emission line excitation is concerned (e.g. Fritsch 1993). The spectral shape was parameterized by a black-body distribution for temperature T_{bb} or by a calculated LTE stellar-atmosphere flux distribution for given T_{eff} taken from Kurucz (1979). A hydrogen density $n_{\text{H}} = 100 \text{ cm}^{-3}$ was chosen. The abundance table and chosen dust grain composition corresponds to a mixture of galactic HII regions as outlined in Ferland (1997). The metal abundances of dwarf galaxies might be lower. However the present data do neither warrant to attempt a detailed study of the abundances nor to 'fine-tune' any fits.

We find that the rather high excitation in the SW knot can be reproduced by a hot stellar ionizing source of $T_{\text{eff}} = 41\,000 \text{ K}$ and an ionization parameter of $\log U = -0.75$ (assuming Q as listed in Tab. 3). Similar results are obtained for a black-body model with $T_{\text{bb}} = 40\,000 \text{ K}$. The lowest excitation, observed in the NE1 knot, can be achieved by either lowering the ionization parameter by about a factor of 10 or by reducing the temperature of the ionizing source to $T_{\text{eff}} = 39\,500 \text{ K}$. The results are shown in Tab. 1. The predicted line ratios for [SII] $\lambda\lambda 6716, 6731$ and [NII] $\lambda 6583$ (not covered by our spectra) are small ($[\text{NII}]/\text{H}\beta \approx 0.2 - 0.5$, $[\text{SII}]\lambda(6716+6731)/\text{H}\beta \approx 0.06 - 0.15$), consistent with the spectrum shown in Veron-Cetty & Veron (1986; but note that it is unclear on which region Veron-Cetty & Veron had pointed).

Above we noted that the extranuclear emission-line regions can be embedded in a bicone centered on the nucleus which is reminiscent of the unified model of AGN. Could the knots be excited by an active nucleus which is hidden from our view by an obscuring molecular ring (see Fig. 1) producing a cone-like geometry of the emission line region? In fact, originally F 348 was classified as Seyfert 2 by Fairall (1981).

To test this possibility, we calculated models with a mean Seyfert continuum as ionizing source, located in the nucleus. The continuum shape from the radio to the optical region was taken from Padovani & Rafanelli (1988) with a break at 10μ and an energy index $\alpha = -2.5$. λ -longwards, an UV-EUV power law with $\alpha_{\text{uv-x}} = -1.4$ (Kinney et al. 1991) extending up to 0.1 keV and an X-ray power law with $\alpha_{\text{x}} = -0.9$ (Nandra & Pounds 1994) extending up to 100 keV followed by a steep break into the gamma-ray region. The distance of the emission line knots from the center is about 2 kpc (neglecting projection effects), resulting in a rather low ionization parameter. We studied a sequence of models with varying ionization parameter and either solar abundances or the same depleted abundances and grain composition as used for the HII region models. Hydrogen densities in the range $\log n_{\text{H}} = 2 - 4$ were considered.

No successful prediction of the observed emission line ratios could be obtained. For those models, in which the strength of [OIII] is correctly reproduced, the [OII] intensity is too strong, and vice versa (Fig. 5). The [OII]/ $\text{H}\beta$ ratio decreases for higher densities $\log n_{\text{H}} \geq 4$ due to the low critical density of [OII], but other low-ionization lines like [SII] and [NII] are much stronger than observed in the spectrum by Veron-Cetty & Veron (1986). For instance, the models shown in Fig. 5 predict $[\text{NII}]/\text{H}\beta \approx 2.5$ and $[\text{SII}]\lambda(6716+6731)/\text{H}\beta \approx 3.0$.

Hence the models show that the observed emission line regions are most likely giant HII regions excited by an internal stellar ionizing source rather than by an AGN-like continuum arising in the galactic nucleus. More detailed model fits will provide further insight when, in addition, red spectra of the individual regions will be available.

3.3. Luminosities and star formation properties

The $\text{H}\beta$ luminosities $L(\text{H}\beta)$, extracted from the long-slit spectra (corrected for internal reddening and in units of $10^{39} h^{-2} \text{ erg s}^{-1}$), are 4.9, 7.0, 1.3 and 3.0 for the SW knot (covering $15''.9$ along the slit corresponding to $2.05 h^{-1} \text{ kpc}$ projected on the sky), the NEKNOT ($12''.5$ or $1.61 h^{-1} \text{ kpc}$), the NE1 and NE2 knots (each $5''.7$ or $730 h^{-1} \text{ pc}$) respectively; we obtain $L(\text{H}\beta) \sim 10^{38} h^{-2} \text{ erg s}^{-1}$ for the C region, assuming an internal reddening between 0 and 2. The luminosities are larger than those observed in typical galactic HII regions (e.g. Kennicutt (1984) found values of $L(\text{H}\beta)$ ranging from $3.5 \cdot 10^{36} \text{ erg s}^{-1}$ in Orion to $7 \cdot 10^{38} \text{ erg s}^{-1}$ in W 49) while they seem to be consistent with those found in extragalactic HII regions ($10^{39} - 10^{40} \text{ erg s}^{-1}$, Searle (1971), Heckman & Balick (1980), Pogge & Eskridge (1987)) and with the range $10^{38} - 10^{42} \text{ erg s}^{-1}$ reported in Dolcetti (1993) for the HII galaxies.

From the $\text{H}\beta$ luminosity and assuming a ratio of 2.85 between $\text{H}\alpha$ and $\text{H}\beta$ we then calculated the luminosity in $\text{H}\alpha$ assuming in this case $h = 0.75$ for a direct comparison with the sample of starburst galactic nuclei (hereinafter SBGN) of Balzano (1983). While for the regions in F 348 $L(\text{H}\alpha)$ ranges from $3.7 \cdot 10^{39}$ to $2 \cdot 10^{40} \text{ erg s}^{-1}$ the SBGN cover $10^{40} - 6 \cdot 10^{42} \text{ erg s}^{-1}$.

Summarizing, F 348 appears to be an association of giant HII regions, where the star formation takes place at a higher rate than normal, but not as violent as in the SBGN of large galaxies.

The mean FWHM of the NE1 and NE2 knots are, respectively, of 200 ± 100 and $160 \pm 70 \text{ km s}^{-1}$ and they are consistent with the mean value of the FWHM given by Balzano (1983) for the SBGN. The FWHM measured in the other spectra appear higher; we found values of 500 ± 200 , 400 ± 200 and $300 \pm 100 \text{ km s}^{-1}$ for the SW knot, the NEKNOT and the C region, respectively.

Fig. 5. Emission line ratios relative to H β in dependence of ionization parameter for AGN-like excitation of the gas, a hydrogen density of $n_H = 1000 \text{ cm}^{-3}$ and HII region abundances with dust, as described in the text. Models with solar abundances show the same trends. The symbols at the right-hand side mark the line ratios as measured for the SW region (circles) and the NE1 knot (squares) and correspond to [OIII], [OII] and [NeIII] from top to bottom. The cross denotes [SII] λ 6716 as estimated from the spectrum of Veron-Cetty & Veron (1986). No simultaneous fit of all line ratios can be achieved.

These line widths are consistent with the highest values found for the SBGN (most of the SBGN have $\text{FWHM} \leq 250 \text{ km s}^{-1}$ but one can find SBGN with FWHM of the order of 300 km s^{-1} ; Balzano 1983). Our spectra indicate some kind of particularly high turbulence between the NE knots and in the SW. High-resolution spectra would be desirable.

The most noteworthy property of the [OIII]-continuum subtracted image (Fig. 1c) compared to the original [OIII] image (Fig. 1a) is the central filament of ionized gas connecting the SW knot with the NE knots. The [OIII] (continuum subtracted) luminosity of the region C (not corrected for internal reddening) is $2.11 \cdot 10^{38} h^{-2} \text{ erg s}^{-1}$ while the SW, NE1 and NE2 knots are, respectively, 60, 9 and 10 times more luminous.

The star formation properties of the three knots of F 348 and of the C region are presented in Tab.3. The luminosities of H β have been used to calculate Q , the rate of H-ionizing photons s^{-1} , emitted by the young stars in the star formation process (for case B; Osterbrock 1989). We then used Q to scale the starburst model D of Rieke et al. (1980) which leads to the quantities given in Table 3. This approach implies to consider F 348 a scaled version of M 82 which should be good enough for some order-of-magnitude estimates.

Table 3. Star formation properties of the emission line knots of F 348 *.

region	$\log Q$ phot s^{-1}	M_* $10^6 M_\odot$	M_c $10^6 M_\odot$	L $10^9 L_\odot$	SN yr^{-1}	SFR $M_\odot \text{ yr}^{-1}$
SW	52.26	9.00	1.80	5.30	$1.8 \cdot 10^{-2}$	0.216
NE1	51.70	2.50	0.50	1.50	$5.0 \cdot 10^{-3}$	0.060
NE2	52.05	5.50	1.10	3.20	$1.1 \cdot 10^{-2}$	0.132
central region	50.00	0.05	0.01	0.03	$1.0 \cdot 10^{-4}$	0.001

* M_* e M_c correspond to the mass in radiating stars and in nonluminous stellar remnants, respectively; L is the total luminosity of the stars; SN is the rate of supernovae per year.

The total stellar masses M_* created in each knot are of the same order of magnitude as the lower limit of $6 \cdot 10^6 M_\odot$ found by Balzano (1983) using the same model of SFR and procedure. The derived SN rates can be compared with the expected FIR and radio luminosity.

F 348 was detected at 60 μm in the IRAS survey with a flux of 0.215 Jy (NED; upper limit 0.727 Jy at 100 μm), corresponding to an upper limit of L_{FIR} of $(3.3 \cdot 10^8/h^2) L_{\odot}$ where L_{FIR} is the luminosity in the range 42.5 to 122.5 μm corresponding to the FIR flux-conversion formula given in Helou et al. (1985). Their FIR-radio correlation predicts an upper limit of 3.1 mJy for the flux density at 1.4 GHz of F 348. This number can be plugged into Condon's & Yin's (1990) semiempirical relationship between 20 cm radio power and supernova rate yielding $\sim 3 \cdot 10^{-3} \text{ SN yr}^{-1}$. Since this should be an upper limit the SN rates of knots SW and NE2 might be considered too high. However, most of the above estimates, including the simple starburst scaling, contain uncertainties of at least a few so that we can faithfully claim broad consistency before more detailed data become available.

4. Concluding discussion

On the basis of blue spectra and an [OIII] image the original classification of F 348 as a Seyfert 2 galaxy cannot be confirmed. Extending the results from the HII region-like spectrum given by Veron-Cetty & Veron (1986), we consider this galaxy a multiple-system HII galaxy in the scheme of Melnick (1978).

We found a dim obscured nuclear region and a biconical knotty arrangement of emission-line gas with luminosities like those of giant HII regions. We ruled out AGN-like excitation and found no hint for interaction. The line ratios can be explained by arising in gas photoionized by hot stars. Estimated star formation properties are consistent with available data.

Due to the lack of significant density waves in dwarf galaxies and the lack of any tidal interaction or merging event in the particular present case the important question is how the star formation is triggered. The morphology of F 348 suggests the following scenario. Star formation first commenced in a nuclear molecular cloud system leading to a large OB association that produced a hot cavity in the center as a result of the shocked stellar winds. After a few 10^6 years the first supernovae exploded each pushing 10^{51} ergs into the bubble that expanded. The bubble was surrounded by a dense expanding shell. As outlined by McCray & Kafatos (1987), on a time scale of 10^7 – 10^8 yrs such a supershell will become unstable leading to new sites of star formation.

Whether we are really witnessing this suggestive scenario can only be decided by a detailed investigation with much more complete data. Since we expect the nucleus to be a faded starburst its faintness gets a natural explanation. Future observations should concentrate on tracers of the age of the bursts.

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