

# NEW GALAXIES WITH HIGH SURFACE BRIGHTNESS IN THE NILSON SYSTEM

G. T. PETROV

*Department of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences,  
Sofia, Bulgaria*

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**Abstract.** The data for 47 new Galaxies with High Surface Brightness (HSBG) are presented. The surface brightness is evaluated by Arakelian's relations in the system of the *Uppsala General Catalogue of Galaxies*. Out of total 193 Arakelian galaxies listed in UGCG, 46 were found to be HSBG in the Nilson system as well.

## 1. Introduction

Arakelian (1974) found, that many physical characteristics of the galaxies correlated with their surface brightness. Amongst them are spectrum emission lines, radioemission, etc. Arakelian (1975) represented a list of 591 galaxies with high surface brightness (HSBG). For evaluation of the surface brightness (SB) Arakelian proceeded as following:

(1) He evaluated the SB of the galaxies in the Vorontsov-Velyaminov *et al.* system of diameters (*Morphological Catalogue of Galaxies*).

(2) He transformed this SB into a system near to Holmberg's one. The main relations for evaluation of SB are:

$$B = m_p - 0.25 \operatorname{cosec} |b^{\text{II}}| + 2.5 \log \left( 3.14 \frac{D \times d}{4} \right), \quad (1)$$

$$B_A = B + 0.22D/d + 0.73, \quad (2)$$

where  $D$  and  $d$  are major and minor axis of the galaxy, respectively, according to the *Morphological Catalogue of Galaxies* (Vorontsov-Velyaminov *et al.*, 1962, 1963, 1964, 1968),  $m_p$  is the integrated magnitude in CGCG (Zwicky *et al.*, 1961, 1963, 1965, 1968), and  $b^{\text{II}}$  is the galactic latitude.

Paturel (1975a) found that correction for inclination effect  $\log D(0) = \log D - k \log(D/d)$  is  $k = 0.16$  for MCG and  $k = 0.23$  for UGCG. Arakelian's correction (2) is based on 100 bright galaxies with detailed surface photometry.

Using Arakelian's criteria we present a list of 47 new galaxies with High Surface Brightness (HSBG) in this paper.

## 2. A List of 47 New Galaxies with High Surface Brightness

Arakelian studied all 15000 galaxies for which simultaneously there are diameters in MCG and magnitudes in CGCG. Only for 621 objects (30 Markarian and 591 Arakelian galaxies)  $B_A = 22.0 m_p s^{-2}$ .\*

Four main lists of diameters of galaxies are known – these are Holmberg, 1958; de Vaucouleurs, 1964, 1976; Vorontsov-Velyaminov *et al.*, 1962–1968; and Nilson, 1973. Yet, the only catalogue with homogeneous magnitudes of galaxies is Zwicky's CGCG.

Paturel (1975b) found, that the average SB is  $B = 25.1$  for UGCG and  $B = 24.4$  for MCG. Paturel (1977) established, too, a surface brightness effect for the Zwicky's magnitudes of galaxies. In this paper we shall not take this effect into account.

There are magnitudes and diameters for many galaxies in UGCG not included in MCG. For all of them we evaluate the SB using relations (1) and (2). Because of the relation between the estimated diameters and the type of galaxies it is impossible to transform Nilson's diameters into Vorontsov-Velyaminov's. But probably there is no mistake in this procedure, because of Nilson's diameters being systematically larger (i.e., lower SB). Other possibilities to evaluate SB more accurately are not used in this paper because:

(1) For the last 10 years the Arakelian galaxies were studied intensively by many astronomers – there are more than 300 radial velocities for all 591 Arakelian galaxies, about 80 galaxies have been observed photoelectrically in the *UBV* system, more than 40 at 3.66 GHz.

(2) Of all Arakelian galaxies 11 are Seyfert galaxies, also, and Akn 120 is variable X-ray source.

To save Arakelian criteria and to have one homogenous list of galaxies with HSB we do not make other corrections and our numbers are a continuation of Arakelian's leaving out all numbers from 592 to 600, in order to avoid mistakes.

The data for the new 47 HSBG (see the plates on pp. 411–432) are presented in Table I, where 1 – is a new No.; 2 – UGCG No.; 3 and 4 – coordinates to equinox 1950.0; 5 –  $m_p$  according to CGCG; 6 –  $D, d$ , major and minor axis on the blue Palomar plates in arc min according to UGCG; 7 –  $B_N$  – SB in magnitudes per square arc sec ( $m_p s^{-2}$ ); 9 – (1) – radial velocities in Palumbo *et al.* (1983); 10 – (2) –  $U, B, V$  – data in Longo and de Vaucouleurs, 1983; 11 – cross-identification, type, remarks.

## 3. Conclusions

In this list there are 19 Zwicky (1971) compact galaxies (40%). For two of them HSB was pointed out by Nilson (1973). In the original Arakelian list there are only 29 (5%) Zwicky galaxies.

Figure 1 represents all Arakelian galaxies from UGCG – 193 objects in all.  $B_N$  is the SB of these objects in the Nilson system of diameters. Using the least-squares method

\* M. A. Arakelian died at the age of 52 only and he could not finish his work on HSBG.

TABLE I  
Data for 47 new galaxies with high surface brightness

| No. | UGCG   | $A_{1950}$ | $D_{1950}$ | $m_p$ | $D' \times d'$ | $B_{m/r}$ | PA   | $V_r$<br>ref. | $UBV$<br>ref. | Remarks               |
|-----|--------|------------|------------|-------|----------------|-----------|------|---------------|---------------|-----------------------|
| 1   | 2      | 3          | 4          | 5     | 6              | 7         | 8    | 9             | 10            | 11                    |
| 601 | 130    | 00 13.3    | + 30 37    | 14.2  | 0.45 × 0.35    | 21.4      | 1257 |               |               |                       |
| 602 | 545    | 00 51.0    | 12 25      | 14.0  | 0.6 × 0.5      | 22.0      | 1274 | 1             | 2             | 1 Zw 1; SyG           |
| 603 | 901    | 01 18.8    | 32 21      | 14.5  | 0.7 × 0.20     | 22.0      | 30   |               |               |                       |
| 604 | 1078   | 01 27.9    | 41 00      | 13.5  | 0.45 × 0.40    | 20.6      | 824  | 1             |               | Pec.                  |
| 605 | 1315   | 01 48.4    | 22 20      | 13.7  | 0.50 × 0.45    | 21.3      | 896  |               |               | 5 Zw 123; N 695       |
| 606 | 1490   | 01 57.8    | 21 03      | 14.1  | 0.50 × 0.22    | 21.2      | 1202 |               |               | Pec.                  |
| 607 | 1632   | 02 05.7    | 29 00      | 14.1  | 0.65 × 0.45    | 22.0      | 1248 |               |               | Pec.                  |
| 608 | 2016   | 02 30.0    | 20 25      | 14.5  | 0.45 × 0.35    | 21.7      | 443  |               |               | IC 235; Mrk 368       |
| 609 | 2143   | 02 36.5    | 35 52      | 14.0  | 0.55 × 0.55    | 21.6      | 407  |               |               | 5 Zw 266; Pec.        |
| 610 | 2467   | 02 57.5    | 42 58      | 14.2  | 0.5 × 0.45     | 21.1      | 1618 |               |               | N 1159                |
| 611 | 3258   | 05 08.1    | 00 21      | 13.9  | 0.7 × 0.6      | 21.9      | 909  |               |               | S B                   |
| 612 | 3393   | 06 00.4    | 07 50      | 14.5  | 0.35 × 0.35    | 19.8      | 229  | 1             | 2             | 2 Zw 42               |
| 613 | 3601   | 06 52.3    | 40 04      | 14.5  | 0.6 × 0.45     | 21.9      | 988  |               |               |                       |
| 614 | 3769   | 07 12.4    | 00 51      | 15.7  | 1.0 × 0.4      | 22.0      | 1491 |               |               | S                     |
| 615 | 4417   | 08 24.3    | 55 52      | 14.3  | 0.2 × 0.2      | 20.0      | 679  | 1             | 2             | 1 Zw 14; Mrk 88       |
| 616 | 4583   | 08 43.1    | 73 50      | 14.4  | 0.35 × 0.35    | 21.2      | 1325 |               |               | N 2636; E O           |
| 617 | 4593   | 08 44.0    | 70 18      | 13.4  | 0.7 × 0.45     | 21.4      | 1325 |               |               | Pec.; Doubl. nucl.    |
| 618 | 5744   | 10 32.1    | 46 49      | 14.1  | 0.45 × 0.40    | 21.5      | 1348 | 1             | 2             | Mrk 146               |
| 619 | 6001   | 10 50.3    | 34 10      | 13.2  | 0.65 × 0.50    | 21.3      | 731  | 1             |               | N 3442; Mrk 418; Pec. |
| 620 | 6070   | 10 56.9    | 33 39      | 13.3  | 0.60 × 0.50    | 21.3      | 731  |               |               | Pec.                  |
| 621 | 6132   | 11 01.7    | 38 28      | 13.1  | 0.8 × 0.6      | 21.7      | 731  | 1             | 2             | Mrk 421; B 2          |
| 622 | 6805   | 11 47.6    | 42 20      | 14.2  | 0.35 × 0.25    | 21.0      | 719  |               |               |                       |
| 623 | 7731   | 12 32      | 82 52      | 14.7  | 0.45 × 0.45    | 21.4      | 1340 |               |               | Prob.*?               |
| 624 | 10099  | 12 54.9    | 42 01      | 14.3  | 0.4 × 0.25     | 21.2      | 1369 | 1             |               | 1 Zw 129 <sup>a</sup> |
| 625 | a10222 | 16 06      | 82 01      | 14.0  | 0.2 × 0.18     | 19.6      | 1363 |               |               |                       |
| 626 | b10222 | 16 06      | 82 01      | 14.0  | 0.15 × 0.15    | 19.0      | 1363 |               |               |                       |
| 627 | 10418  | 16 28.0    | 75 00      | 14.2  | 0.25 × 0.22    | 20.2      | 1433 |               |               |                       |
| 628 | 10572  | 16 47.8    | 63 04      | 13.5  | 1.1 × 0.30     | 22.0      | 1410 |               |               | N 6247; Pec.          |
| 629 | 10635  | 16 56.3    | 38 17      | 13.5  | 0.7 × 0.7      | 21.9      | 1069 |               |               |                       |
| 630 | 11130  | 18 07.2    | 69 49      | 14.4  | 0.15 × 0.15    | 19.4      | 801  | 1             | 2             | 7 Zw 768; 3C 371      |
| 631 | 11172  | 18 12.2    | 69 55      | 14.0  | 0.20 × 0.20    | 19.6      | 801  |               |               | 7 Zw 776              |
| 632 | 11338  | 18 40.9    | 35 34      | 14.5  | 0.50 × 0.45    | 21.6      | 148  |               |               | Pec.                  |
| 633 | a11608 | 20 37.2    | 27 04      | 10.5  |                | 16.8      | 332  |               |               |                       |
| 634 | b11609 | 20 37.2    | 27 04      | 10.5  | 0.55 × 0.35    | 16.8      | 332  |               |               | 4 Zw 64; Prob.**?     |
| 635 | a11668 | 21 00.4    | 36 30      | 15.5  | 0.15 × 0.15    | 18.8      | 279  |               |               |                       |
| 636 | b11668 | 21 00.4    | 36 30      | 14.0  | 0.30 × 0.30    | 18.8      | 279  |               |               | 4 Zw 67               |
| 637 | 11761  | 21 29.6    | 34 18      | 13.8  | 0.18 × 0.18    | 18.5      | 269  |               |               | 4 Zw 71               |
| 638 | 11762  | 21 29.8    | 29 55      | 13.0  | 0.15 × 0.15    | 17.5      | 803  |               |               | 4 Zw 72               |
| 639 | 11763  | 21 30.0    | 09 56      | 14.3  | 0.5 × 0.20     | 21.2      | 799  | 1             | 2             | 2 Zw 136; SyG         |
| 640 | 11823  | 21 47.8    | 34 43      | 14.0  | 0.20 × 0.15    | 18.8      | 815  |               |               | 4 Zw 78               |
| 641 | 11865  | 21 56.2    | 11 48      | 14.3  | 0.5 × 0.5      | 21.9      | 1137 | 1             |               | Mrk 518               |
| 642 | a12011 | 22 20.8    | 30 40      |       | 0.25 × 0.20    |           | 383  |               |               | Kar 567a <sup>b</sup> |
| 643 | b12011 | 22 20.8    | + 30 40    | 14.0  | 0.20 × 0.15    | 21.8      | 383  |               |               | Kar 567b              |
| 644 | 12339  | 23 02.1    | - 01 45    | 14.0  | 0.25 × 0.22    | 20.1      | 905  |               |               |                       |
| 645 | 12376  | 23 04.9    | + 15 36    | 14.0  | 0.2 × 0.2      | 19.7      | 1161 |               |               | 7 Zw 93               |
| 646 | 12389  | 23 06.1    | 46 38      | 13.8  | 0.7 × 0.5      | 21.2      | 1162 |               |               | 5 Zw 398              |
| 647 | 12419  | 23 10.3    | + 15 38    | 14.0  | 0.2 × 0.2      | 19.7      | 320  |               |               | 3 Zw 95               |

<sup>a</sup> Kojoian *et al.* (1981) have made a mistake in identifying Akn 490 with UGC 10099.

<sup>b</sup> Surface brightness for  $D \times d = 0.6 \times 0.6$ . If the magnitudes of the components are 14, 0,  $B_N = 19.7$ , respectively.

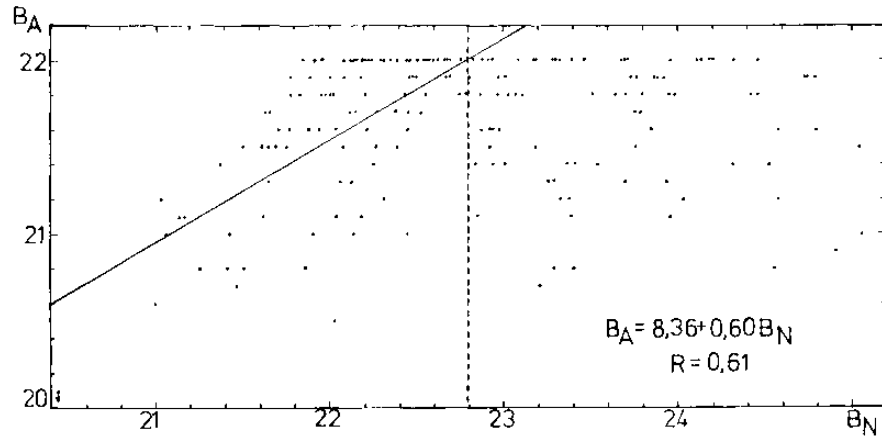


Fig. 1. Surface brightness for 193 Arakelian galaxies in the Nilson system.

we seek to construct the relations between  $B_N$  and  $B_A$  in the forms  $B_A = a + bB_N$  and  $B_A = a + b \ln B_N$ . In both cases the correlation coefficients are very small. There is a good correlation only for galaxies with  $B_N = 22.8 m_p 2^{-2}$  ( $R = 0.61$ ). This relation is presented in Figure 1. The parameters of linear regression are  $a = 8.36$  and  $b = 0.60$ . The mean value of SB of 193 Arakelian galaxies in the Nilson system is  $\overline{B_N} = 22.7$  and the variance is  $\sigma^2(B_N) = 0.92$ . Only 46 objects figure simultaneously as HSBG in both systems. These galaxies are listed in Table II, where Akn is the No in Arakelian's (1975) list, UGCG is the No in Nilson (1973) catalogue and  $B_N$  is SB in  $m_p s^{-2}$  in the Nilson system.

TABLE II  
Arakelian galaxies, who are HSBG in the Nilson system

| Akn | UGCG | $B_N$ | Akn | UGCG | $B_N$ | Akn | UGCG | $B_N$ | Akn | UGCG  | $B_N$ |
|-----|------|-------|-----|------|-------|-----|------|-------|-----|-------|-------|
| 19  | 540  | 21.9  | 122 | 3414 | 22.0  | 250 | 5796 | 21.8  | 428 | 8725  | 21.6  |
| 37  | 913  | 21.6  | 136 | 3930 | 21.5  | 259 | 5964 | 21.8  | 449 | 9220  | 21.9  |
| 41  | 953  | 21.2  | 142 | 4051 | 21.4  | 264 | 6003 | 21.9  | 468 | 9700  | 21.5  |
| 45  | 1007 | 22.0  | 147 | 4111 | 22.0  | 272 | 6119 | 21.5  | 504 | 10407 | 22.0  |
| 55  | 1220 | 21.6  | 149 | 4160 | 21.8  | 283 | 6255 | 22.0  | 532 | 11000 | 21.9  |
| 56  | 1236 | 21.8  | 173 | 4508 | 21.1  | 311 | 6655 | 21.9  | 541 | 11290 | 22.0  |
| 70  | 1467 | 21.7  | 202 | 5025 | 21.8  | 312 | 6665 | 21.0  | 542 | 11566 | 22.0  |
| 71  | 1510 | 21.9  | 214 | 5229 | 21.4  | 340 | 6979 | 21.0  | 558 | 12074 | 22.0  |
| 72  | 1520 | 21.8  | 218 | 5261 | 21.7  | 353 | 7283 | 22.0  | 585 | 12779 | 21.1  |
| 77  | 1672 | 21.9  | 237 | 5561 | 22.0  | 361 | 7466 | 21.6  | 588 | 12842 | 21.6  |
| 79  | 1757 | 21.4  | 238 | 5588 | 21.6  | 372 | 7658 | 20.4  |     |       |       |
| 91  | 2296 | 22.0  | 248 | 5749 | 21.7  | 380 | 7778 | 21.2  |     |       |       |

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*Rem.: North is at the top, Fields are about 16' x 12'.*

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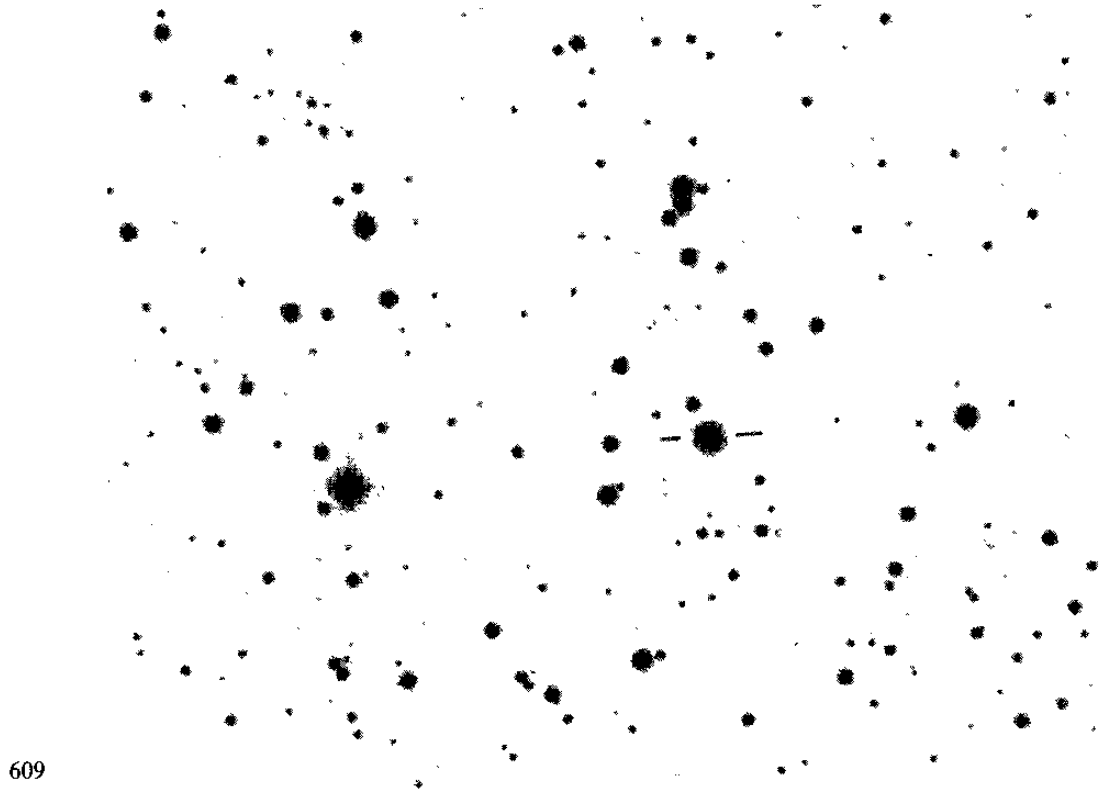
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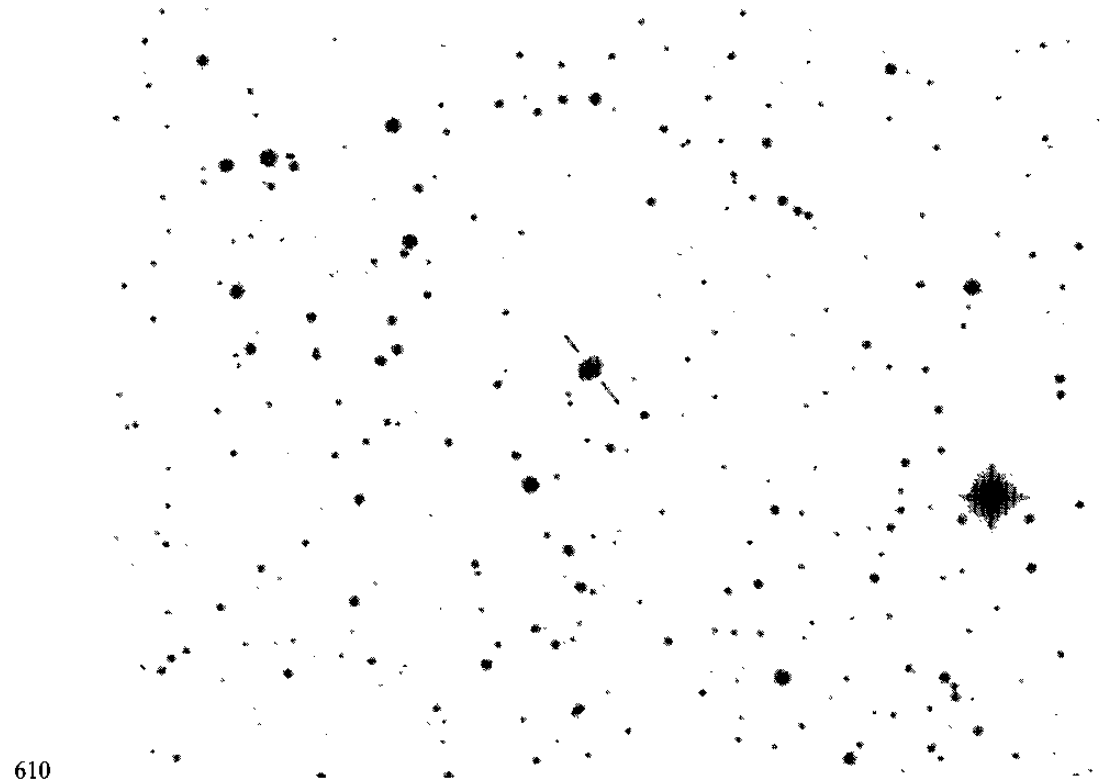
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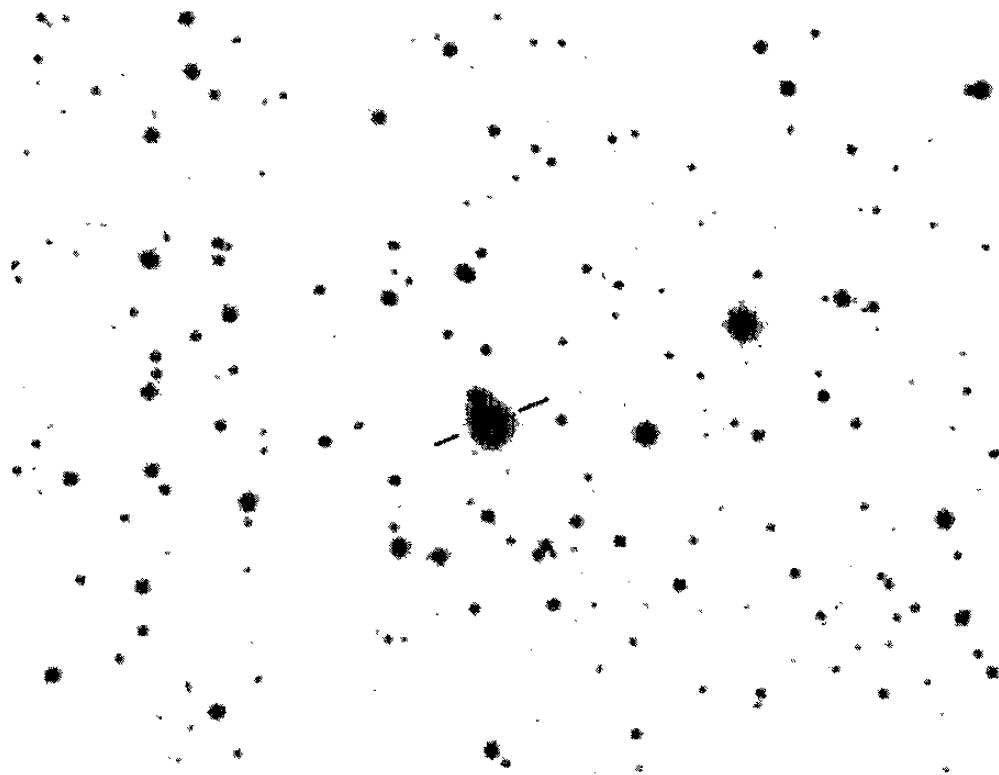


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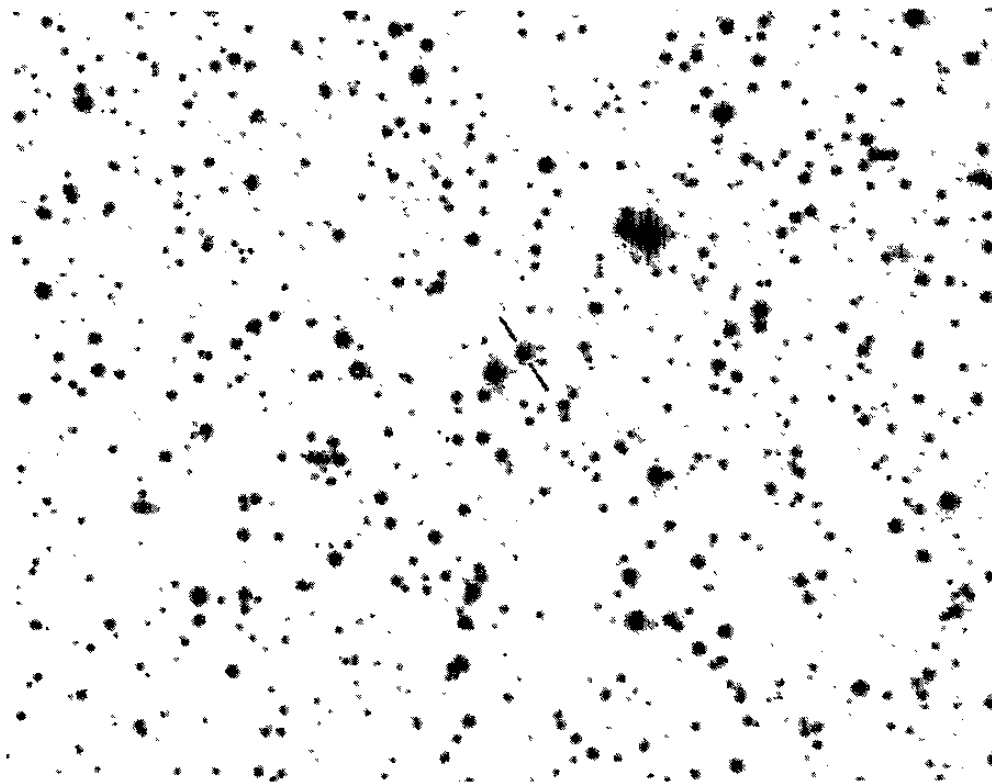


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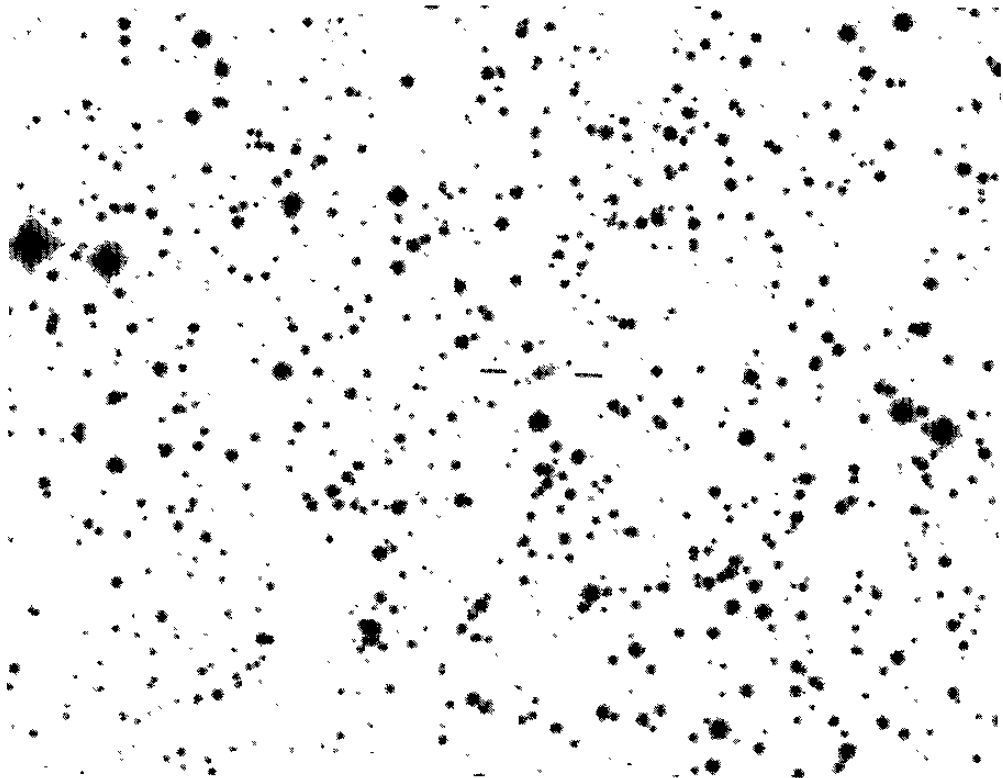
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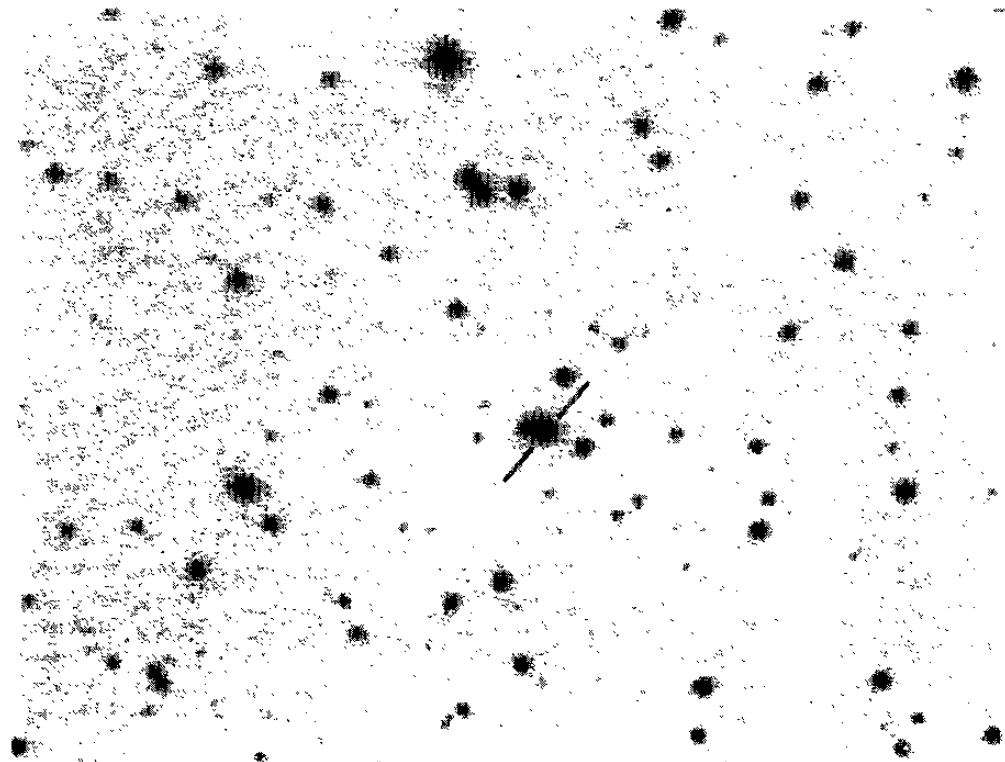
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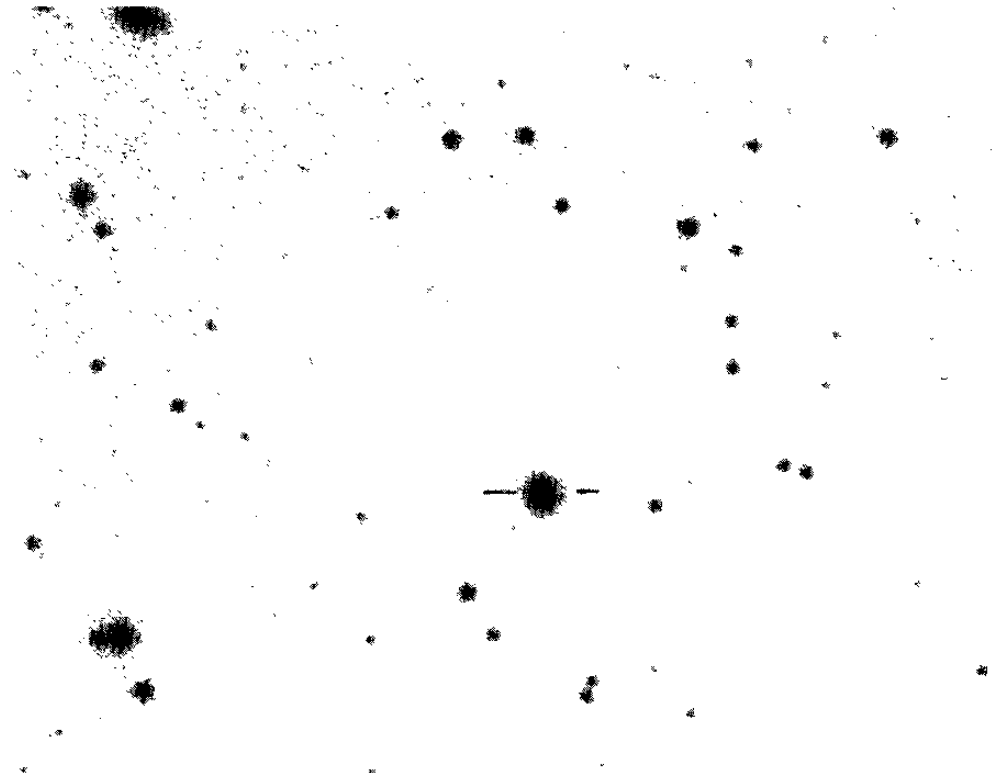
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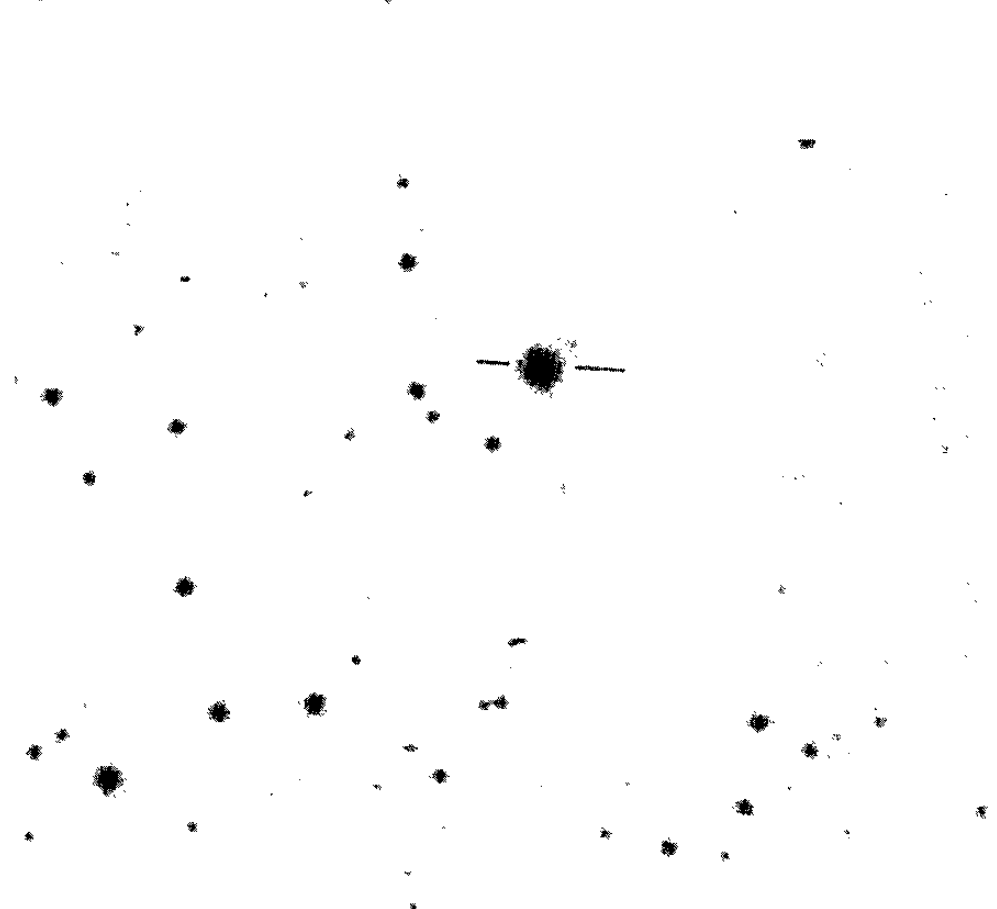
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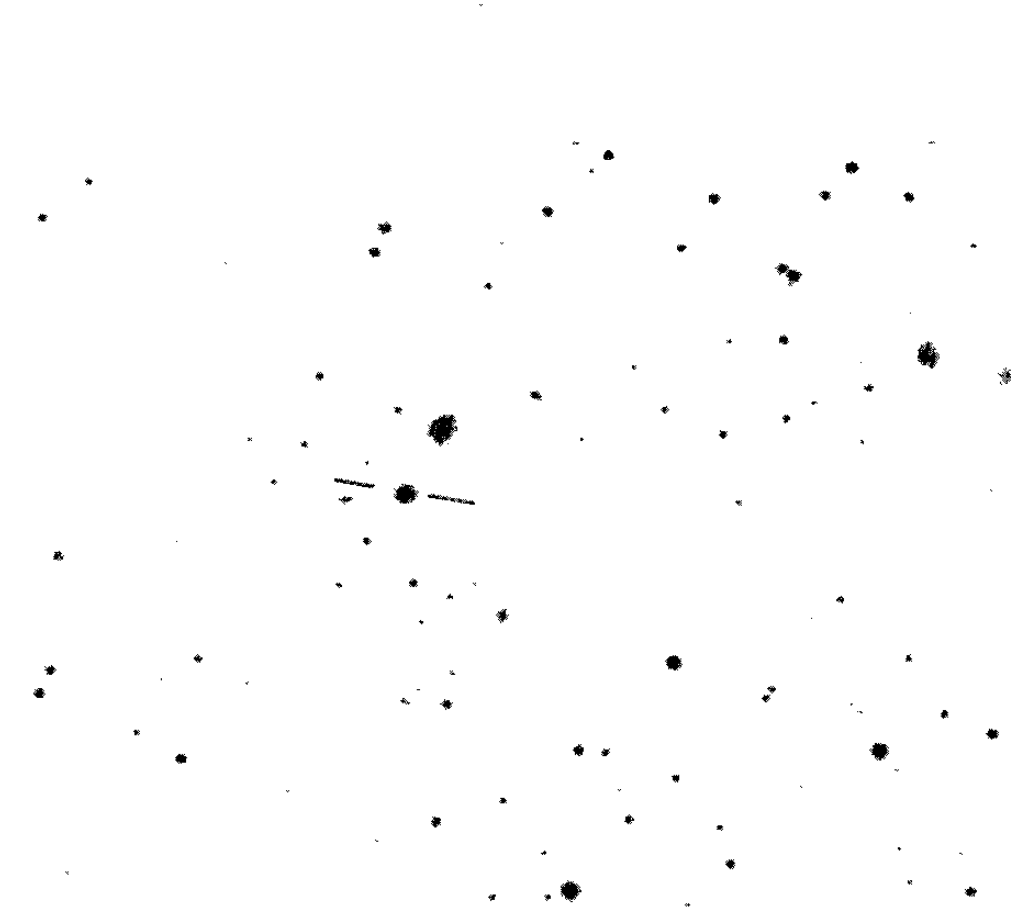
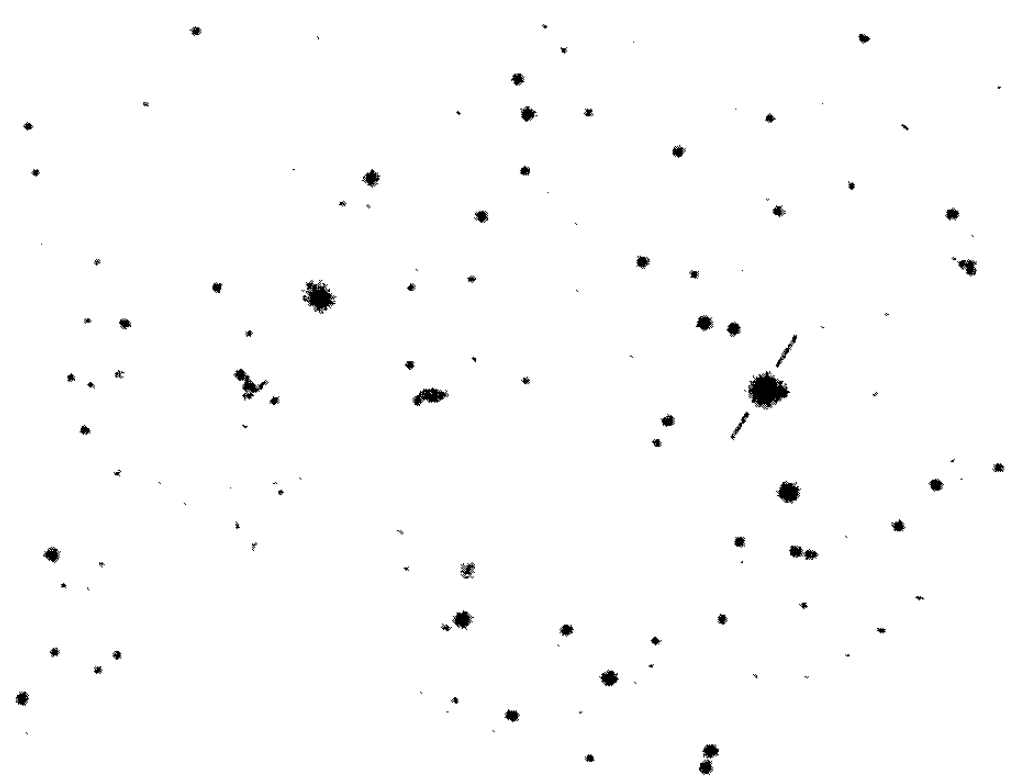
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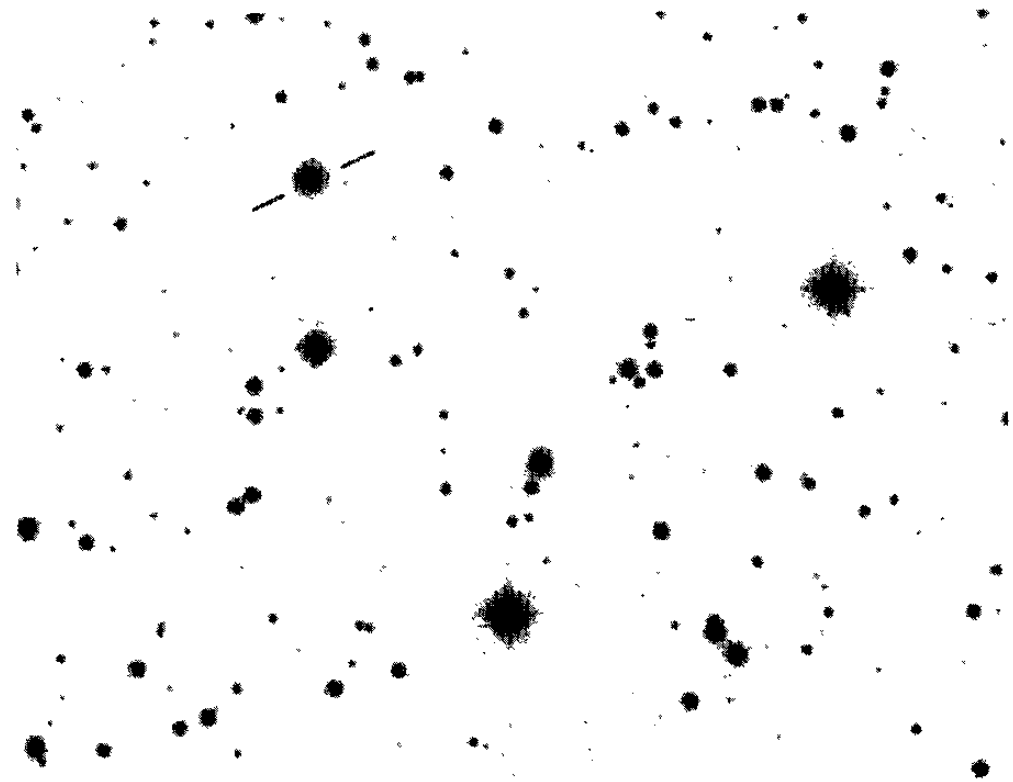
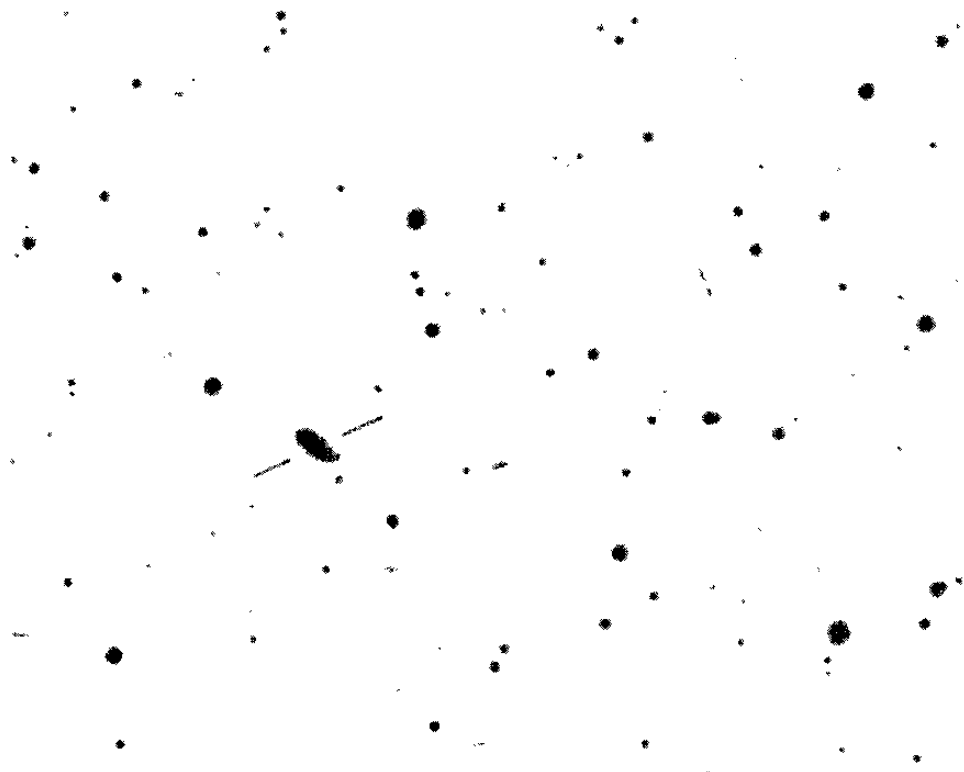


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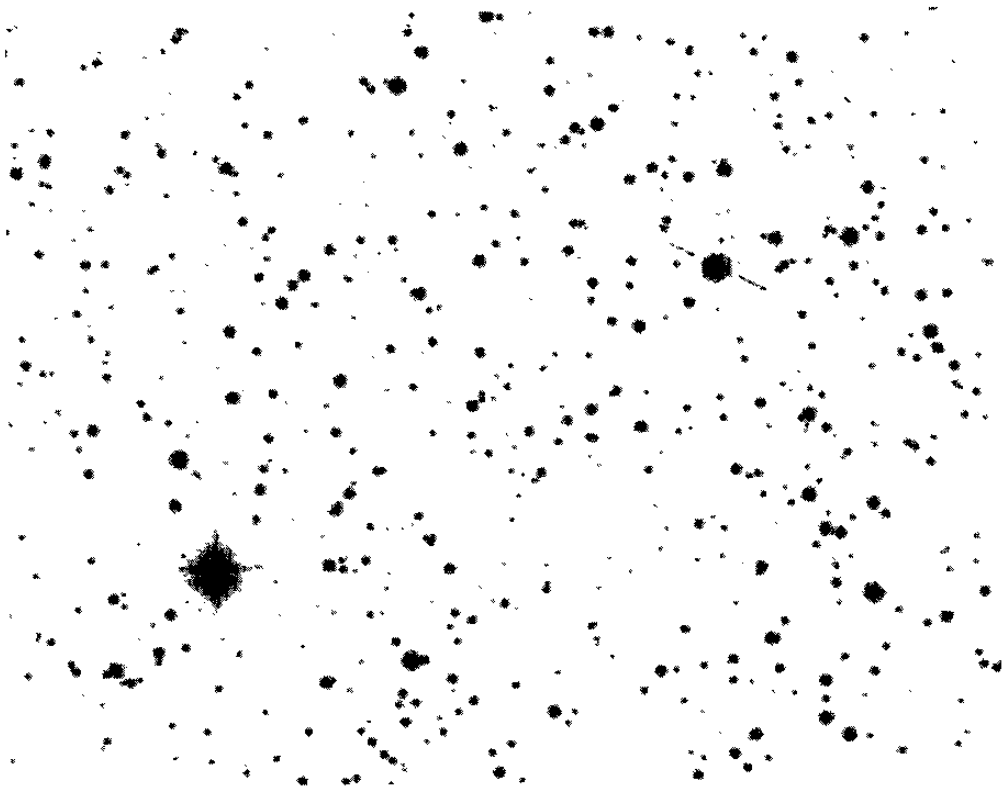


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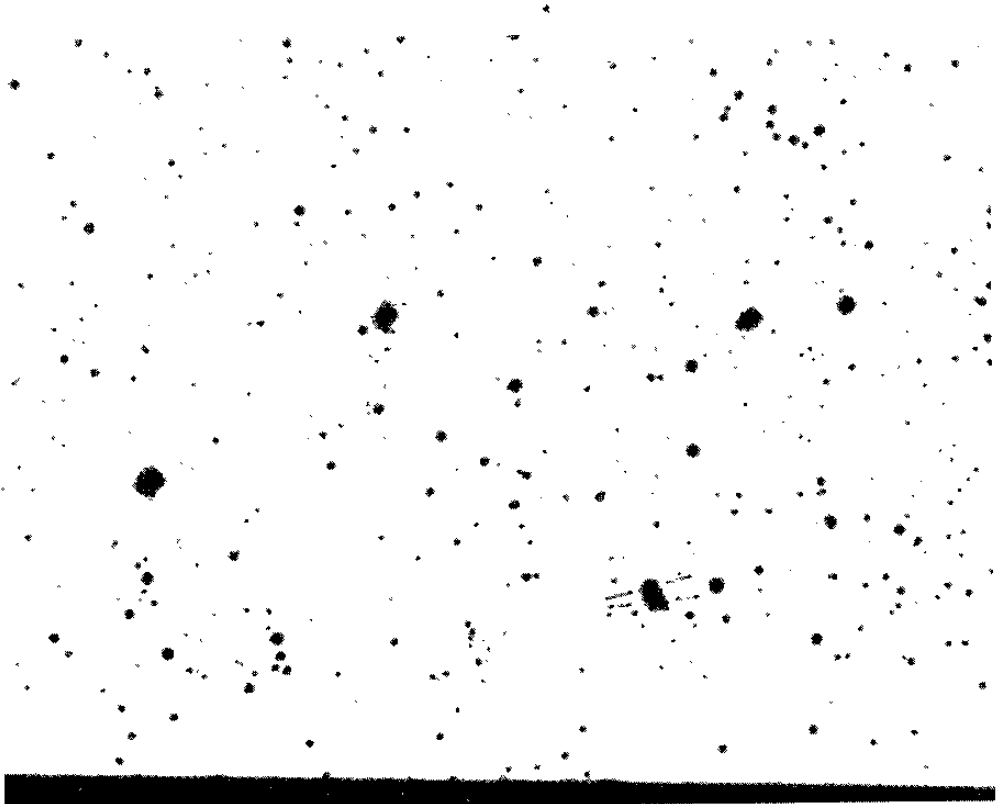
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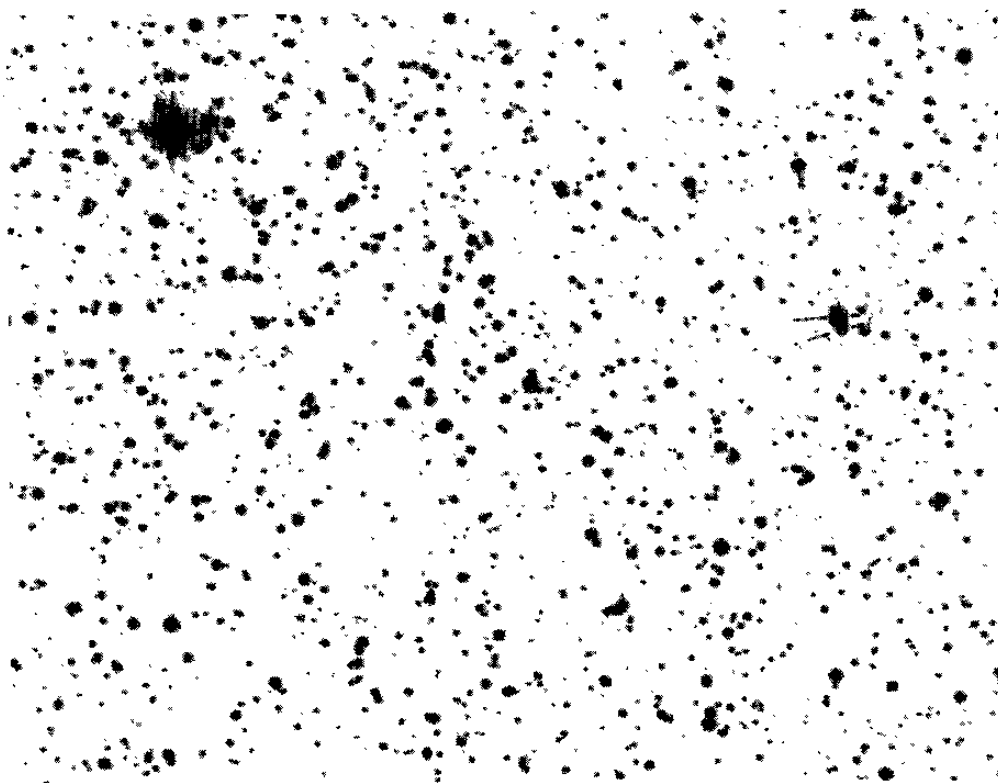
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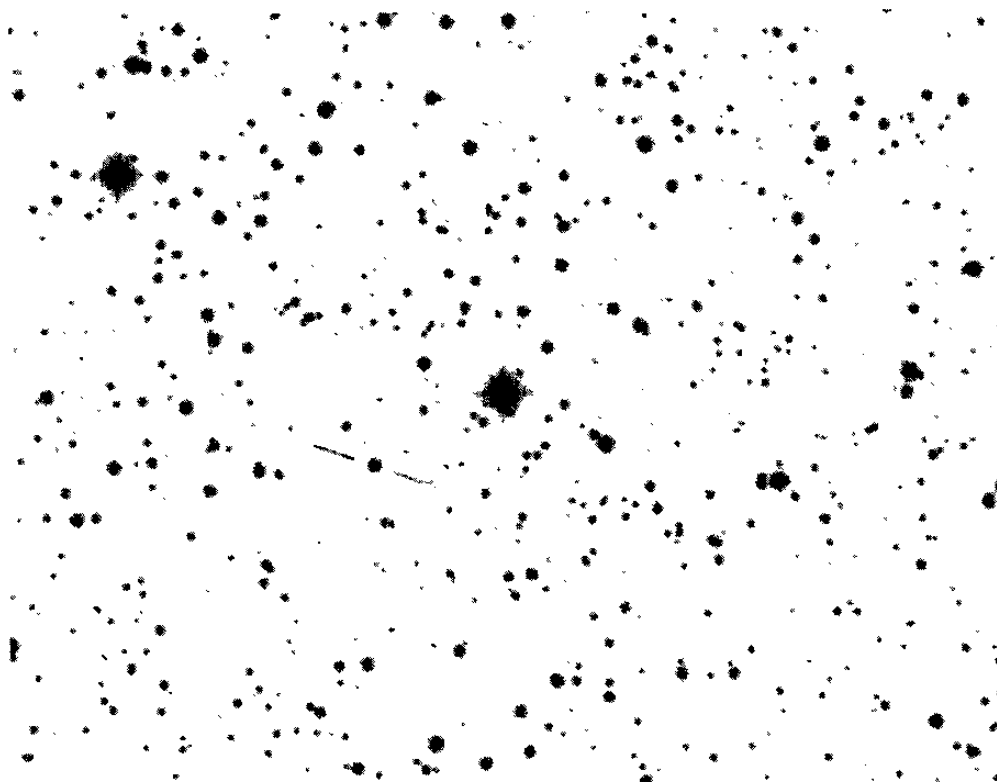
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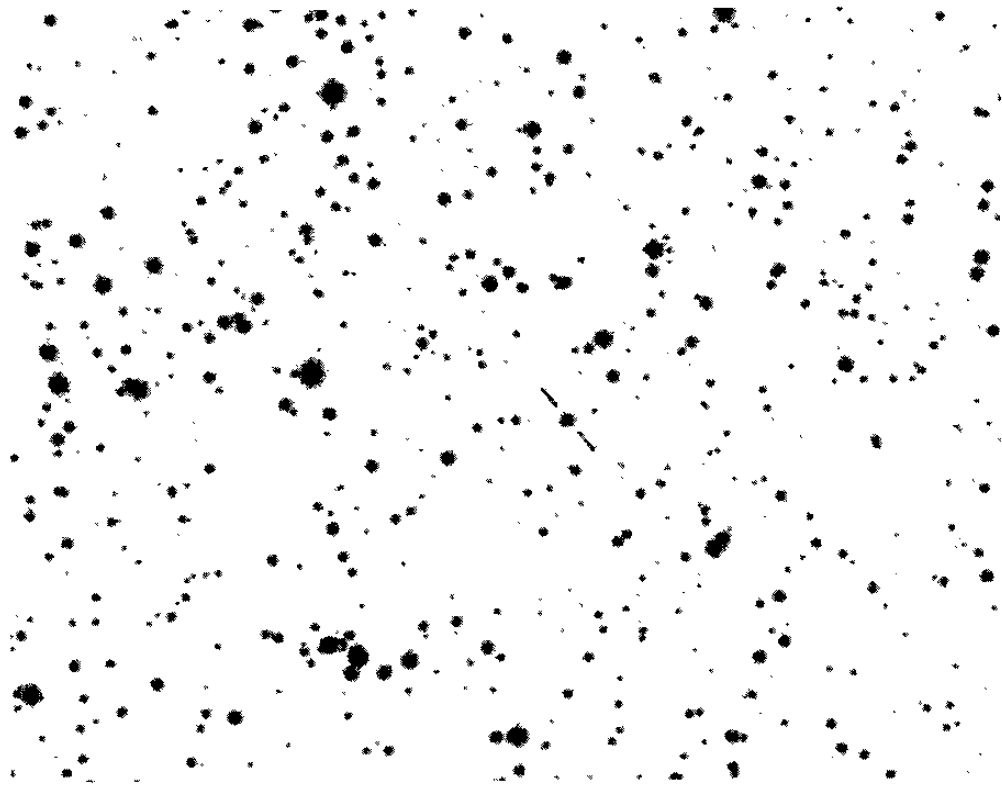


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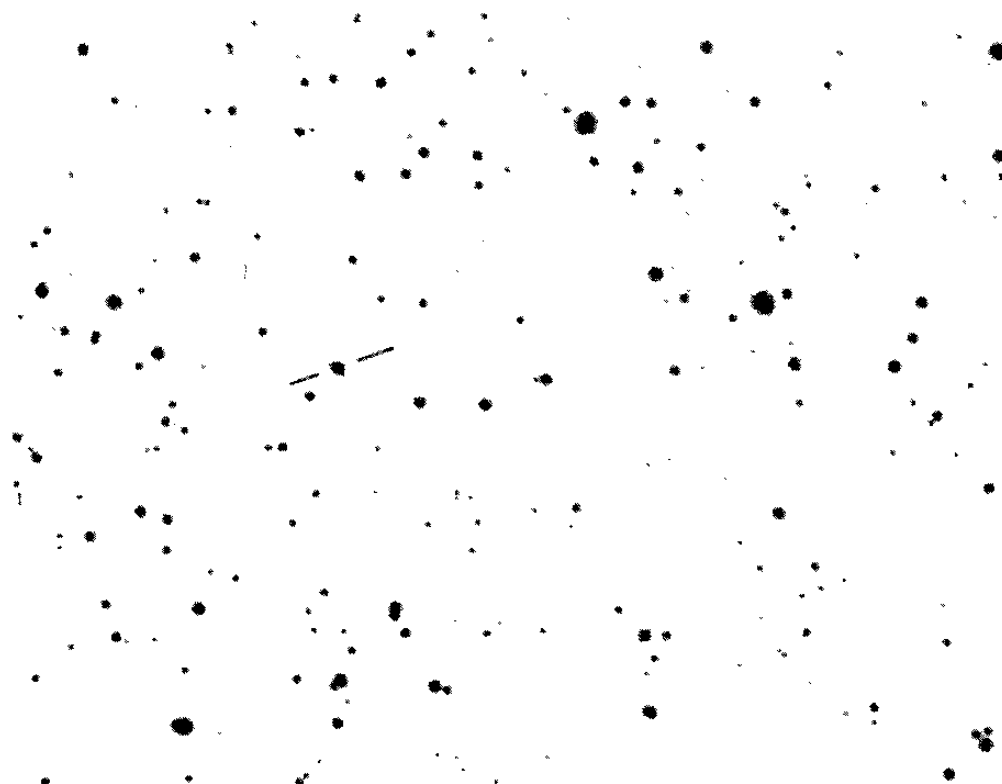


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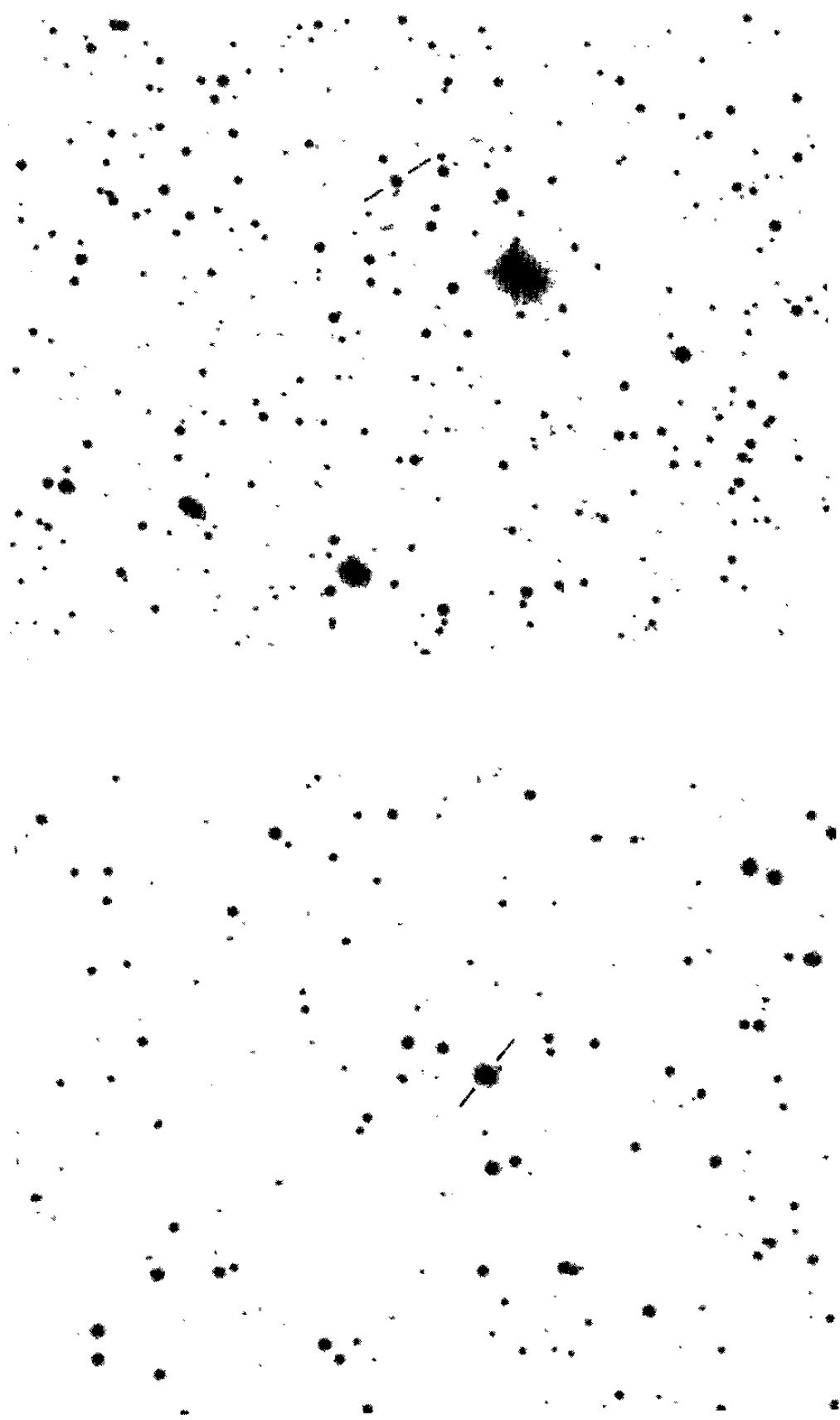


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