

Artificial Intelligence in the search for Asteroids

<http://bit.ly/aistroid>

Jorge I. Zuluaga

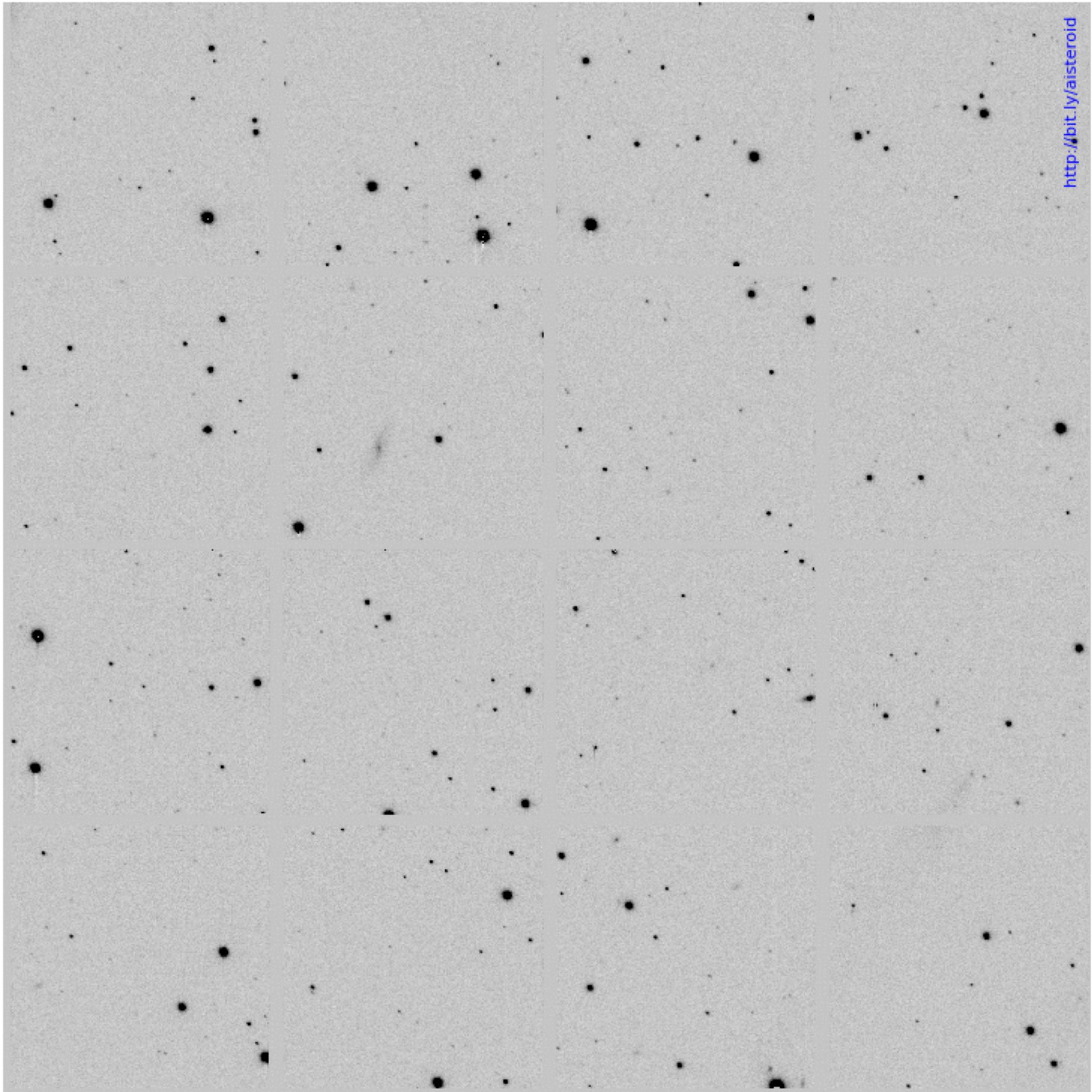
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Instituto de Física – Universidad de Antioquia

Jonathan Ospina, Liliana Piedrahita, Iván Moreno, Sergio López

NEA, Nacidos para Encontrar Asteroides (Colombia)
International Asteroid Search Campaign

Encuentre los asteroides

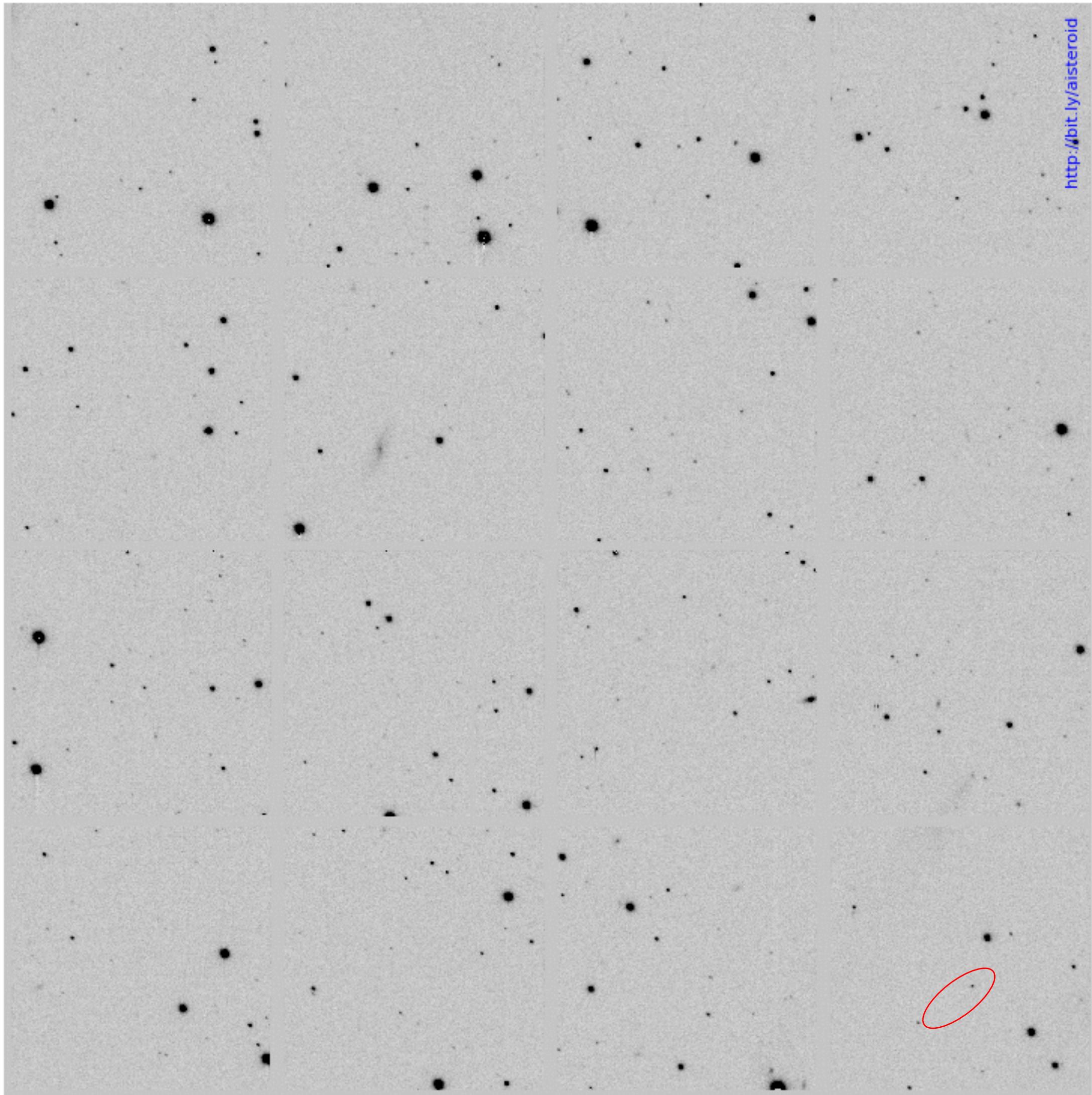
Set psl-20170913_1_set142, Image 0: 2017-09-13T07:34:37.398042



<http://bit.ly/aistroid>

Encuentre los asteroides

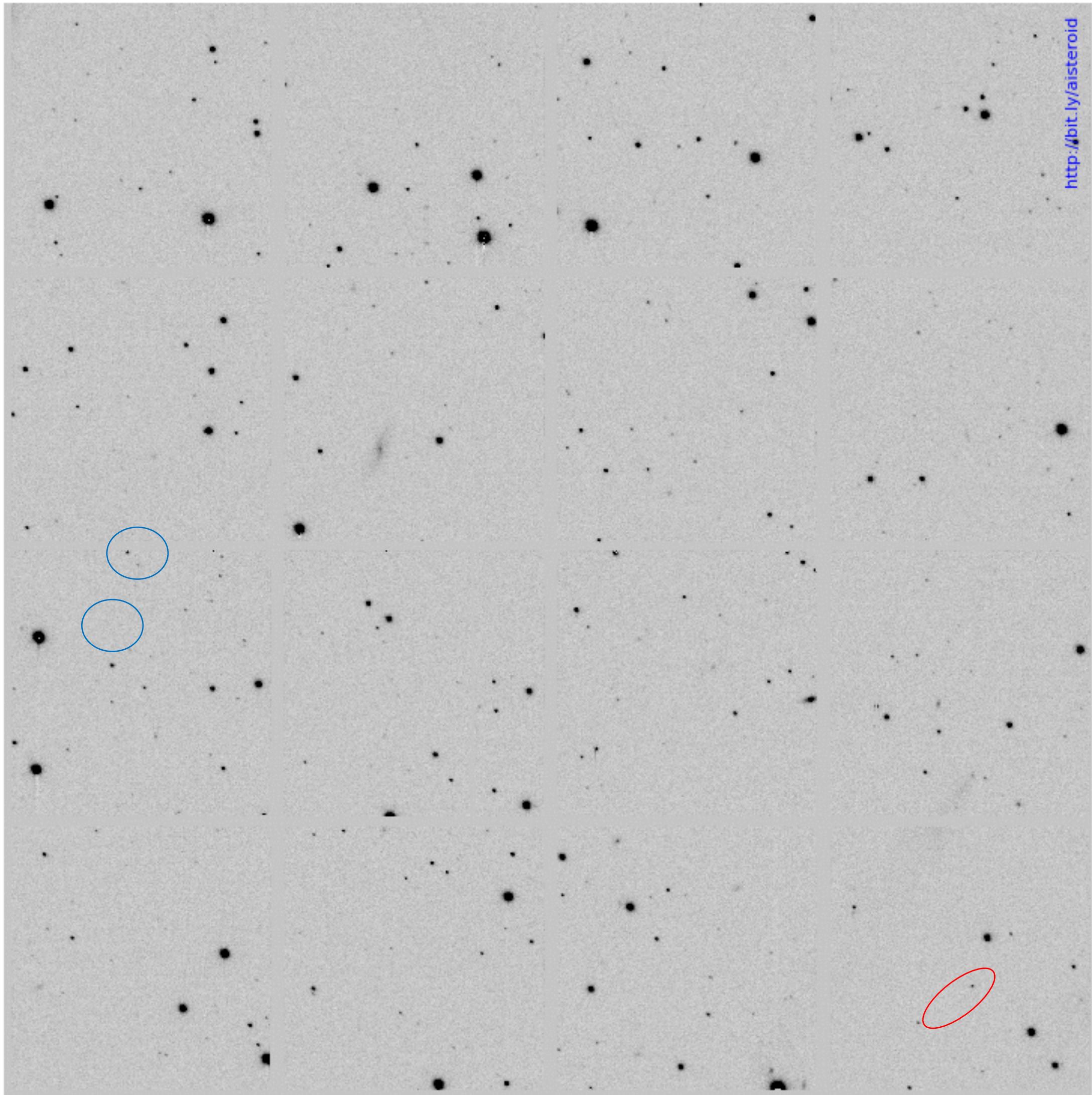
Set psl-20170913_1_set142, Image 0: 2017-09-13T07:34:37.398042



<http://bit.ly/aistroid>

Encuentre los asteroides

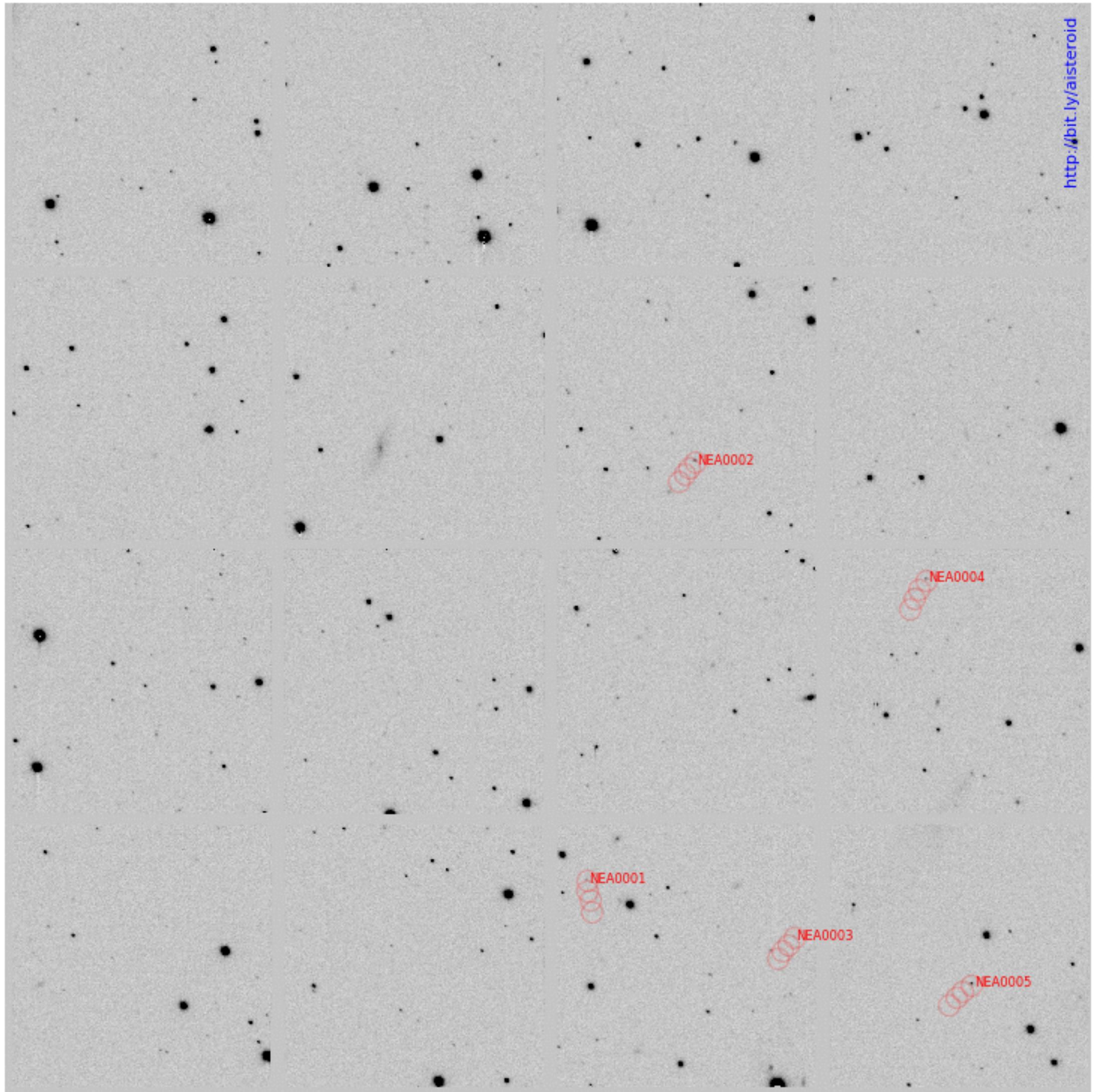
Set psl-20170913_1_set142, Image 0: 2017-09-13T07:34:37.398042



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Así lo ve un ojo entrenado o una máquina

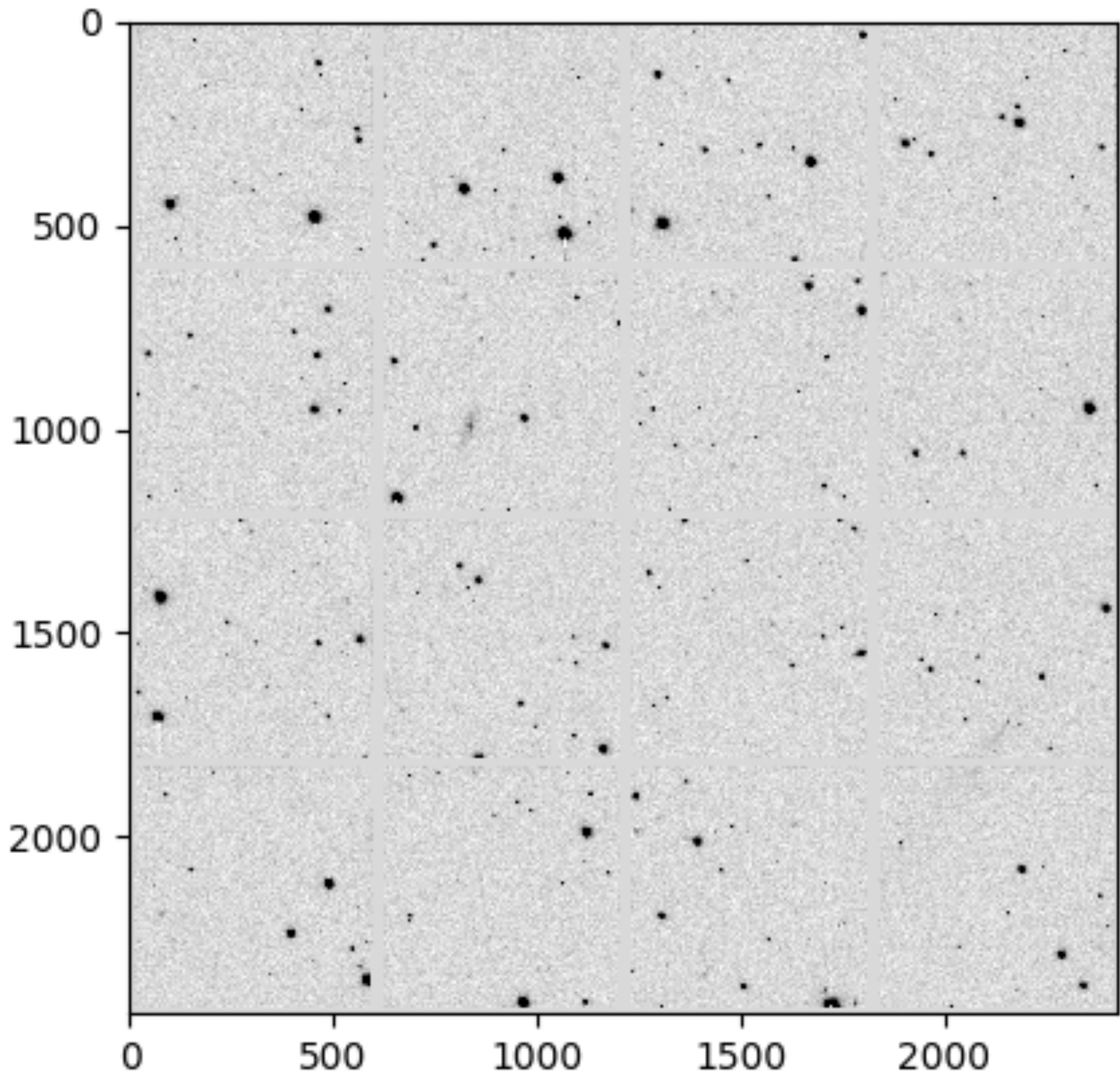
Set psl-20170913_1_set142, Image 0: 2017-09-13T07:34:37.398042



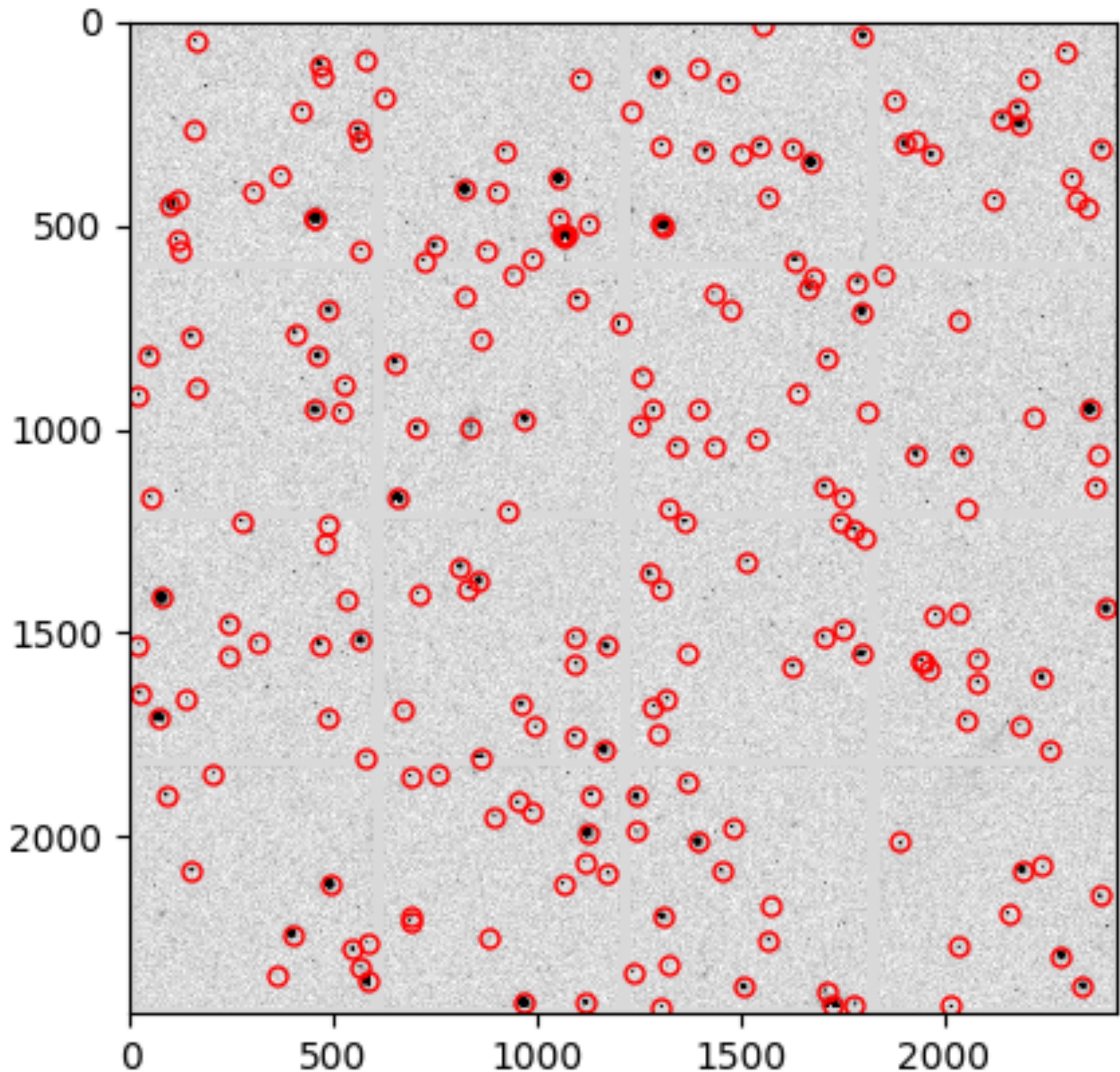
¿Cómo “enseñar” a
un computador a
detectarlos?

Detectas las fuentes
de Luz

¿Dónde están las fuentes?

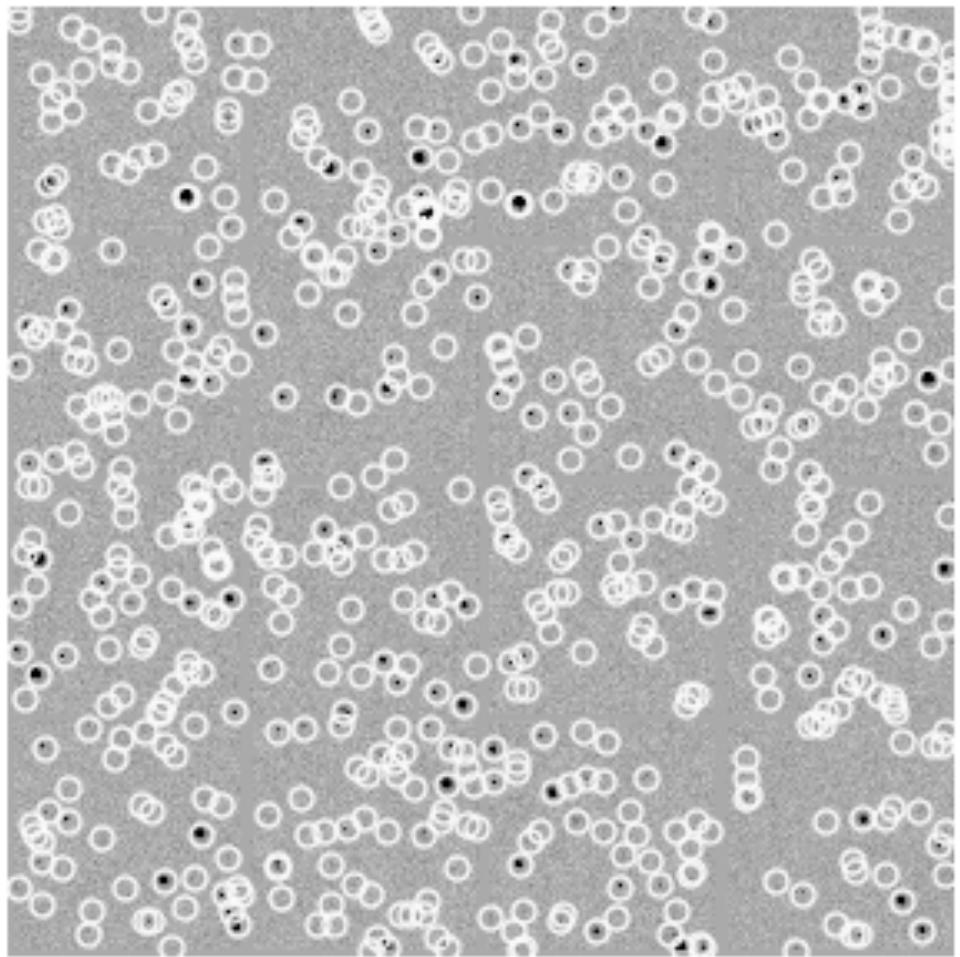


¿Dónde están las fuentes?

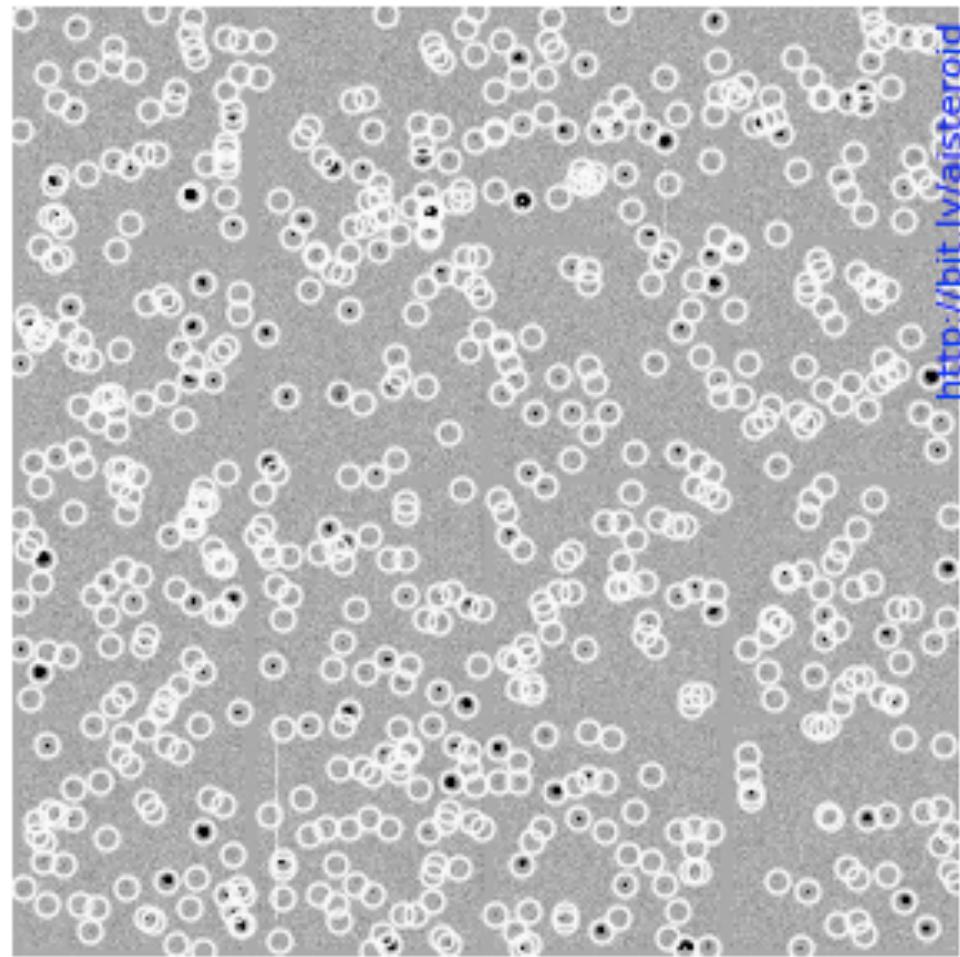


¿Dónde están las fuentes?

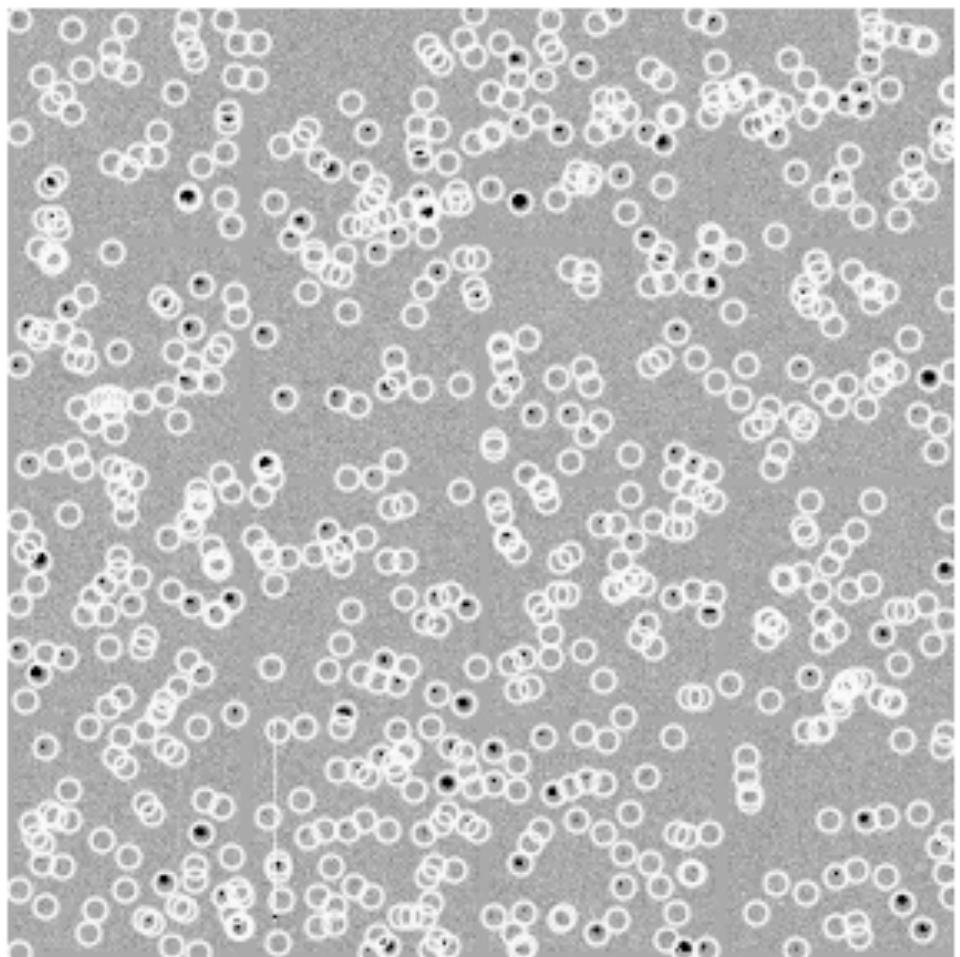
o8009g0075o.1299949.ch.1991737.XY51.p10
Time:2017-09-13T07:34:37.398042



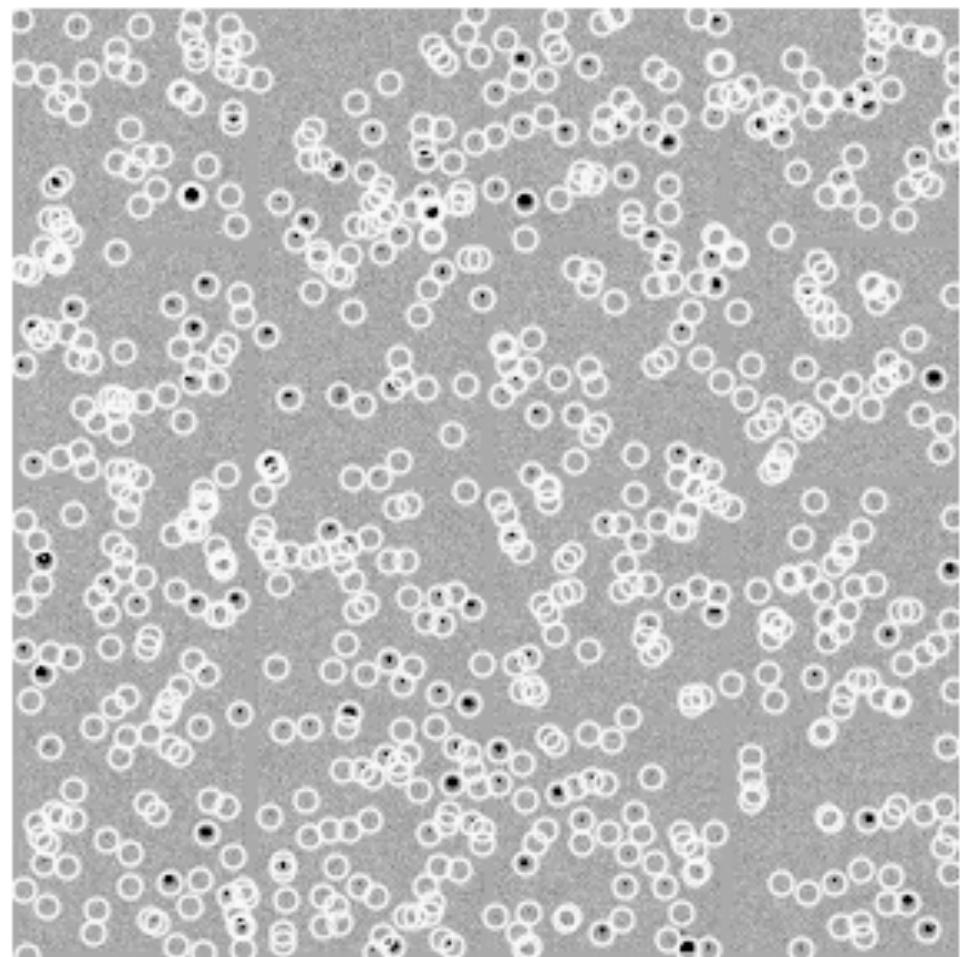
o8009g0096o.1299970.ch.1991758.XY51.p10
Time:2017-09-13T07:54:13.669204



o8009g0117o.1299991.ch.1991779.XY51.p10
Time:2017-09-13T08:13:48.666774

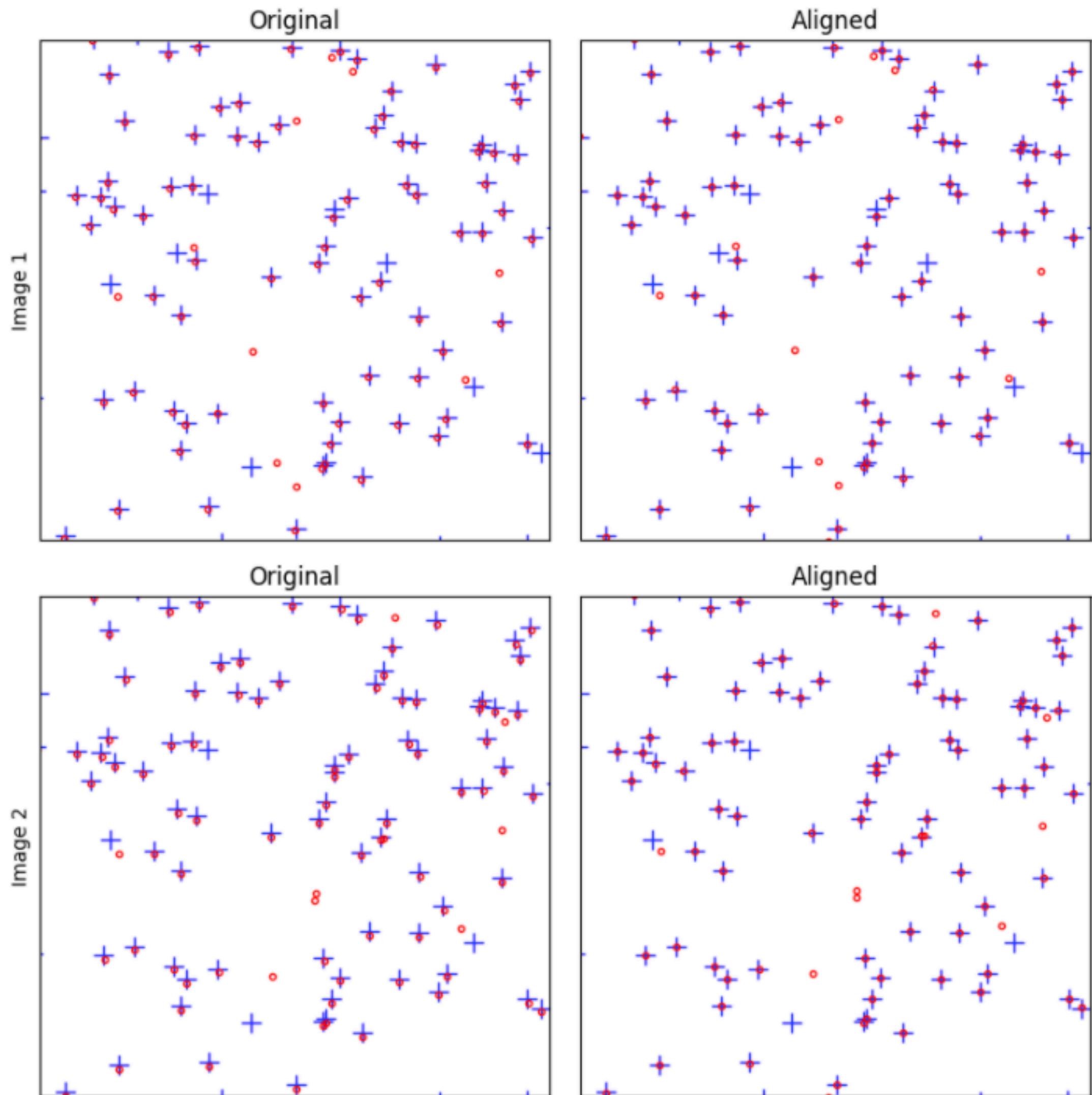


o8009g0138o.1300012.ch.1991800.XY51.p10
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Alinea las fuentes
entre imágenes

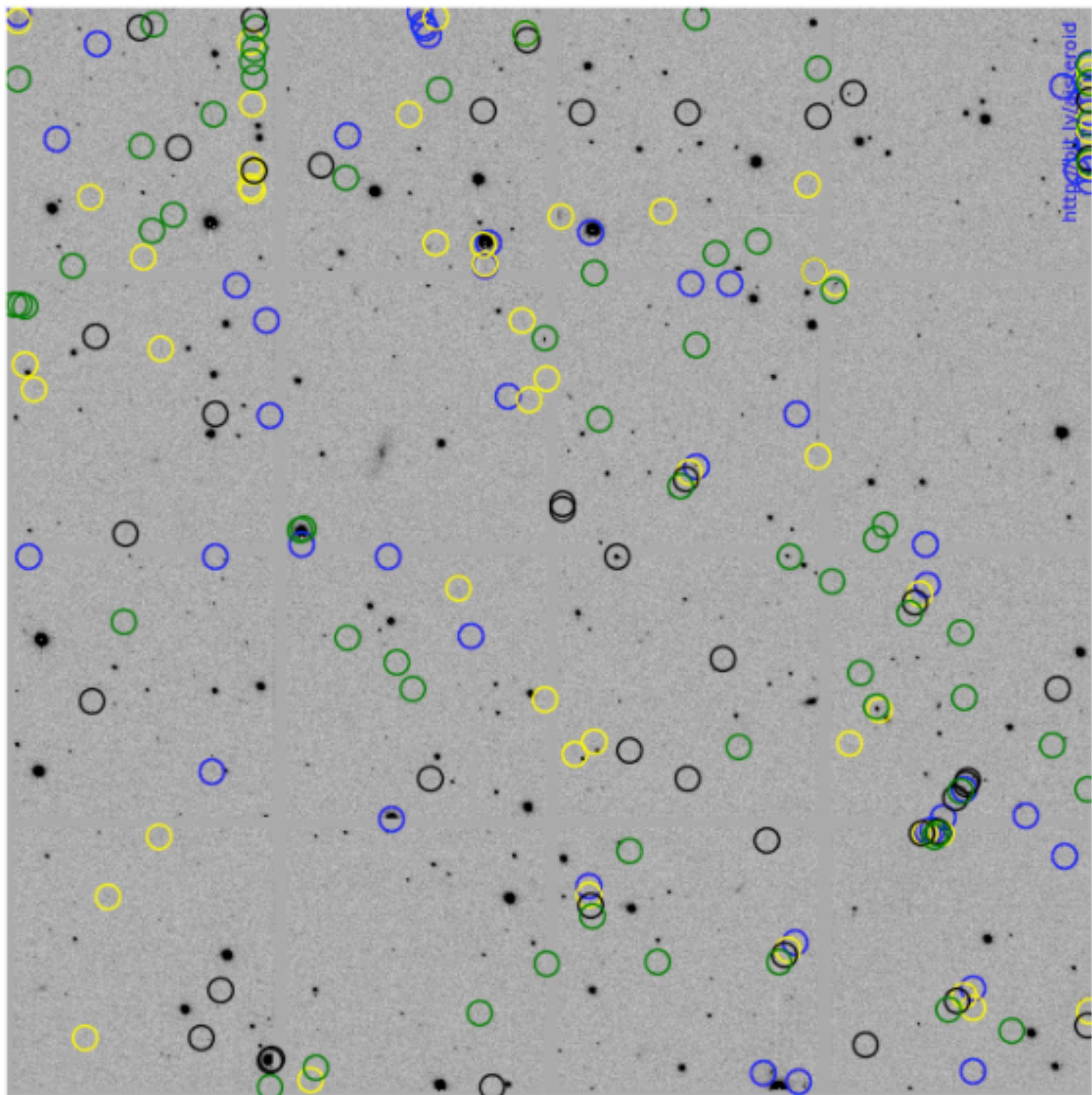
Las imágenes no son perfectas



Busca las fuentes
que se movieron

Orden: azul, amarillo, negro y verde

o8009g0075o.1299949.ch.1991737.XY51.p10
Time:2017-09-13T07:34:37.398042

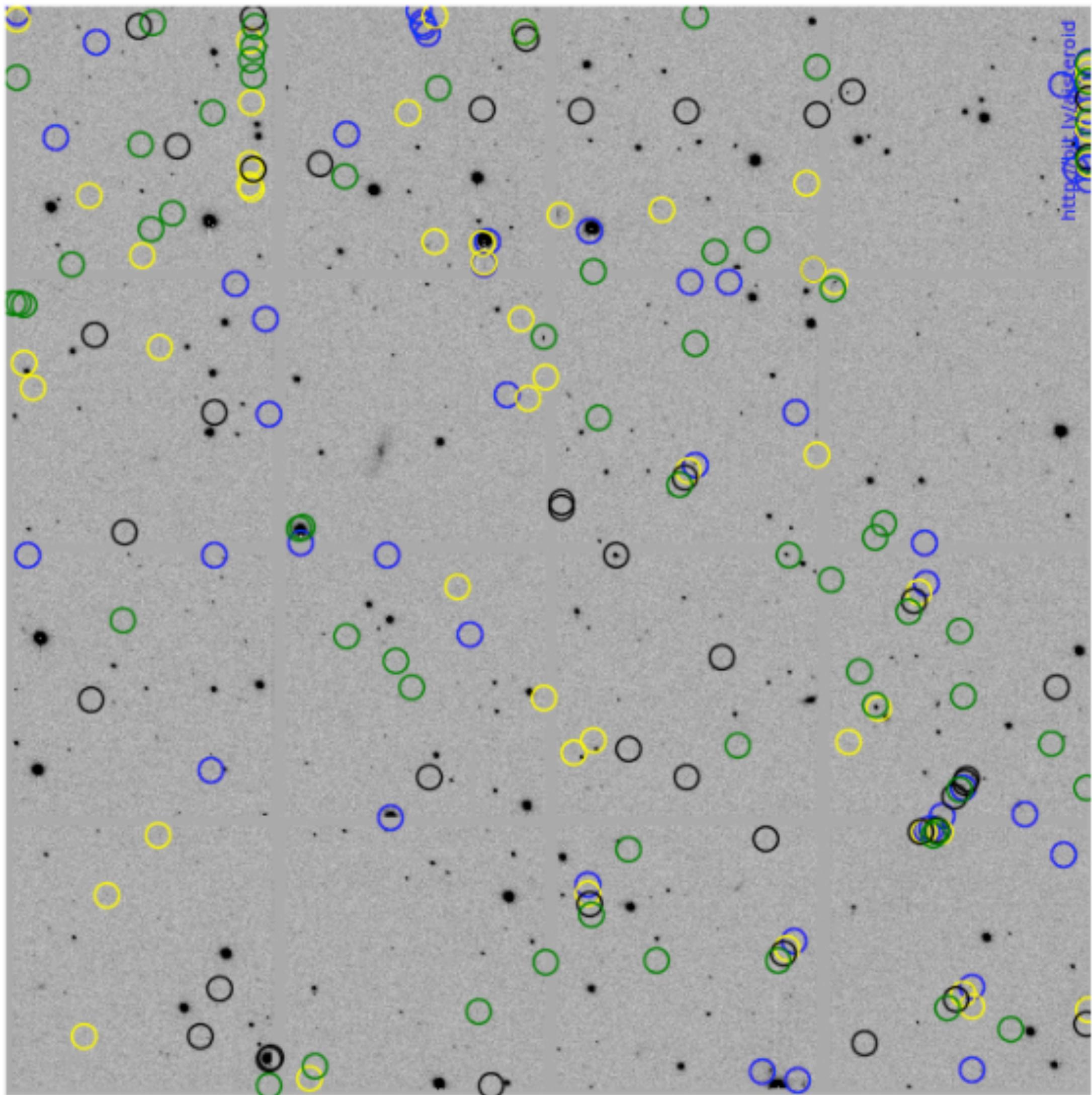


La convención es fácil de conseguir



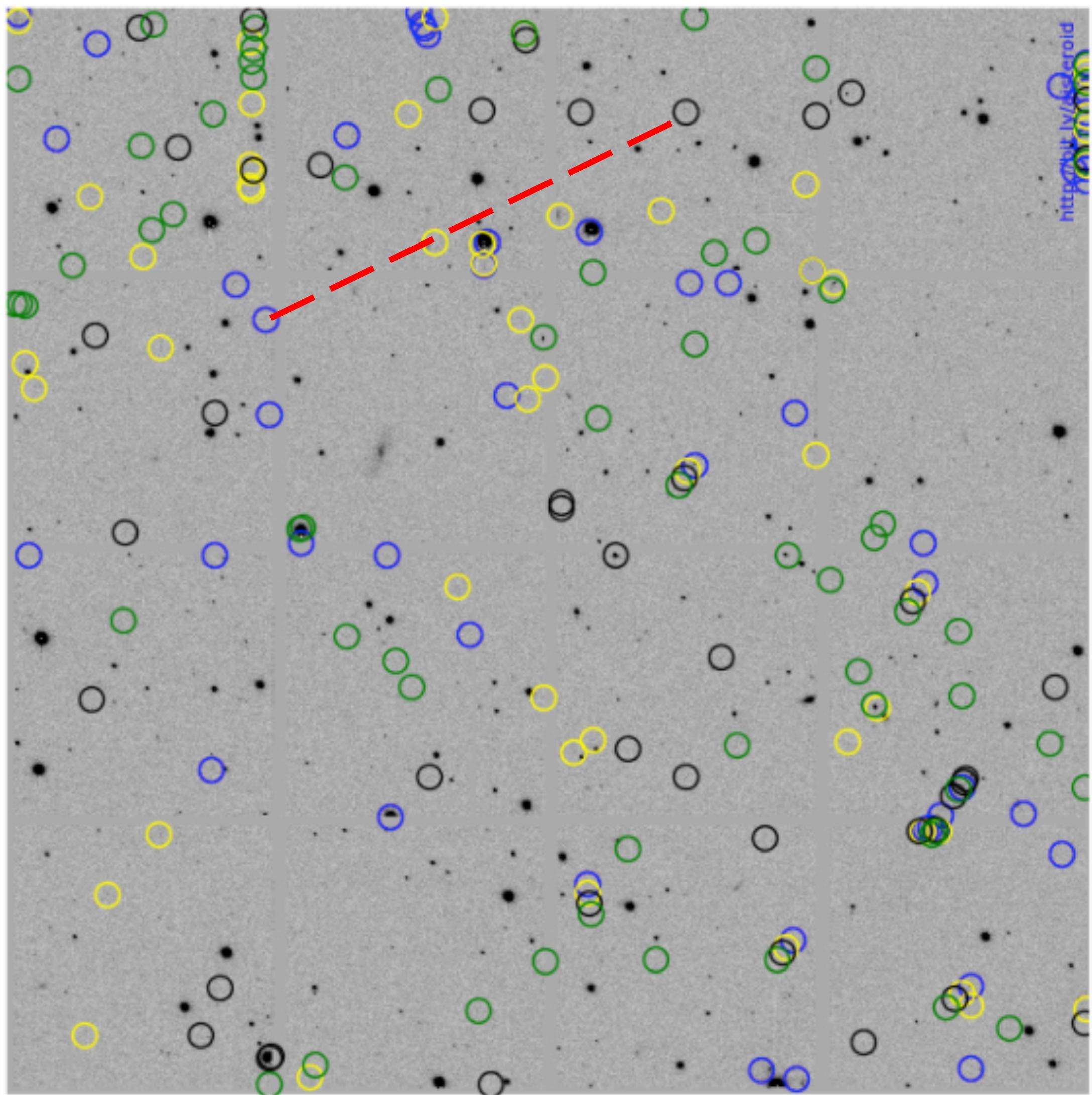
¿Ven los asteroides?

o8009g0075o.1299949.ch.1991737.XY51.p10
Time:2017-09-13T07:34:37.398042



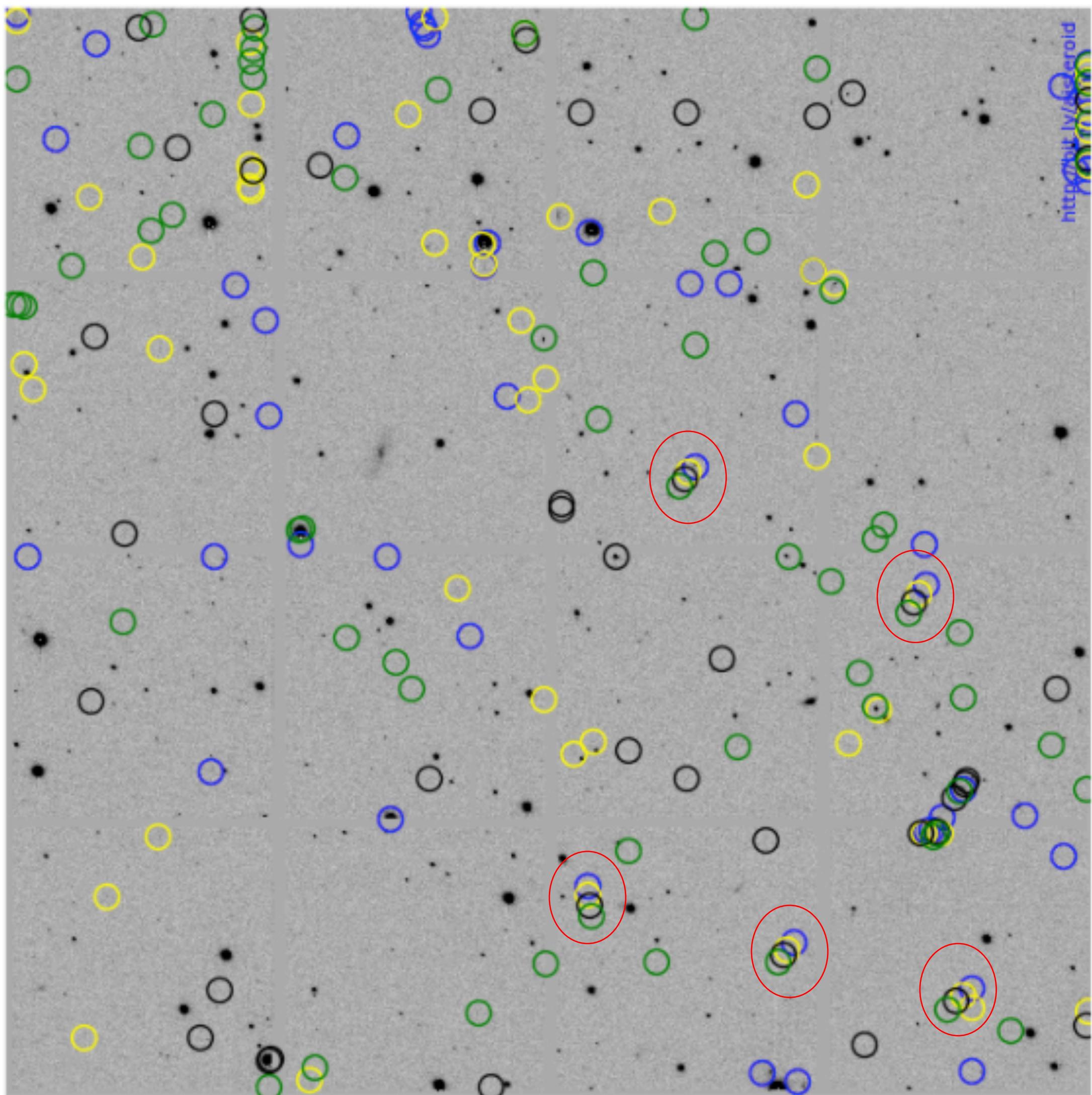
¿Podría ser este?

o8009g0075o.1299949.ch.1991737.XY51.p10
Time:2017-09-13T07:34:37.398042



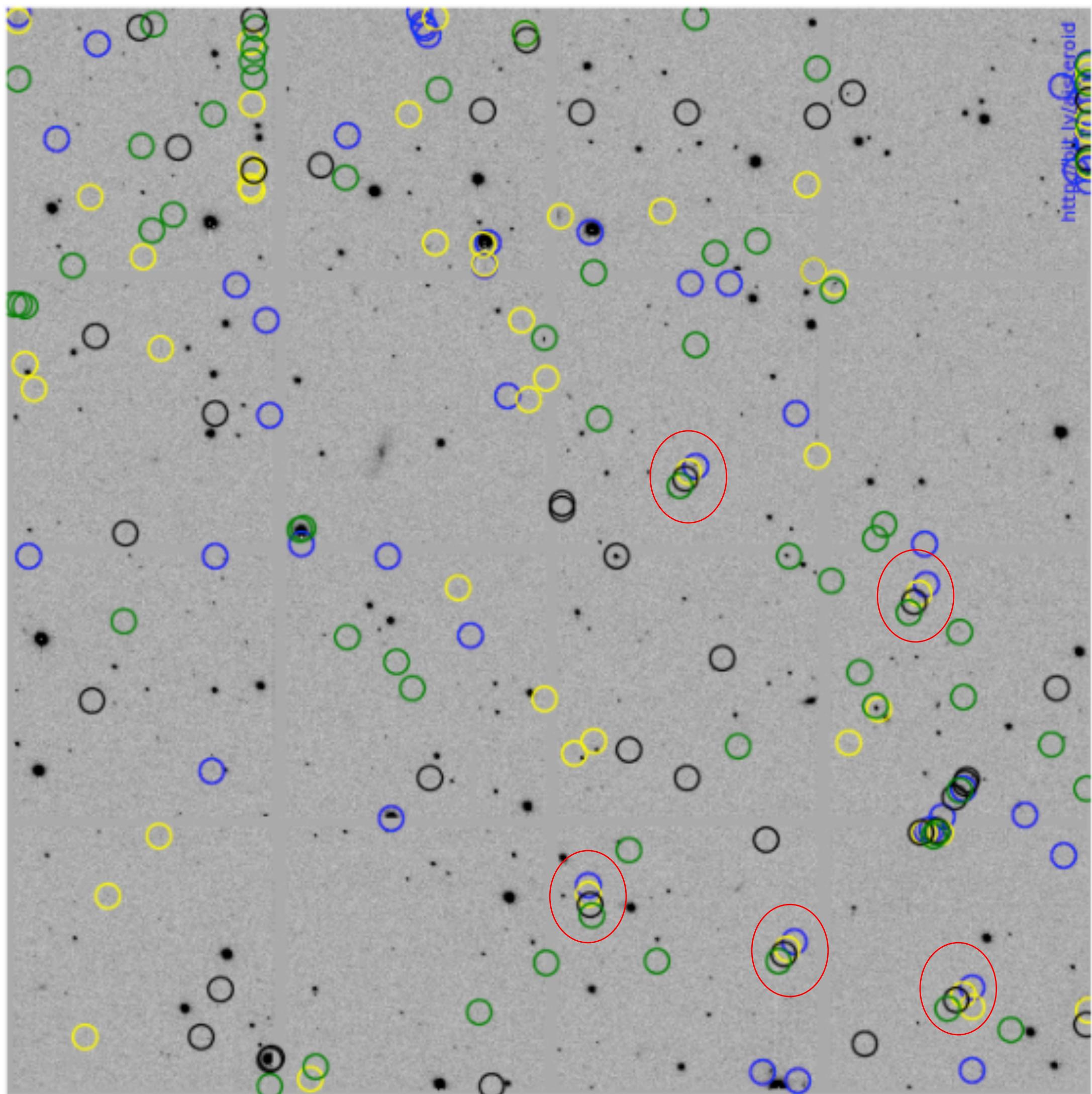
El cerebro los ve...

o8009g0075o.1299949.ch.1991737.XY51.p10
Time:2017-09-13T07:34:37.398042

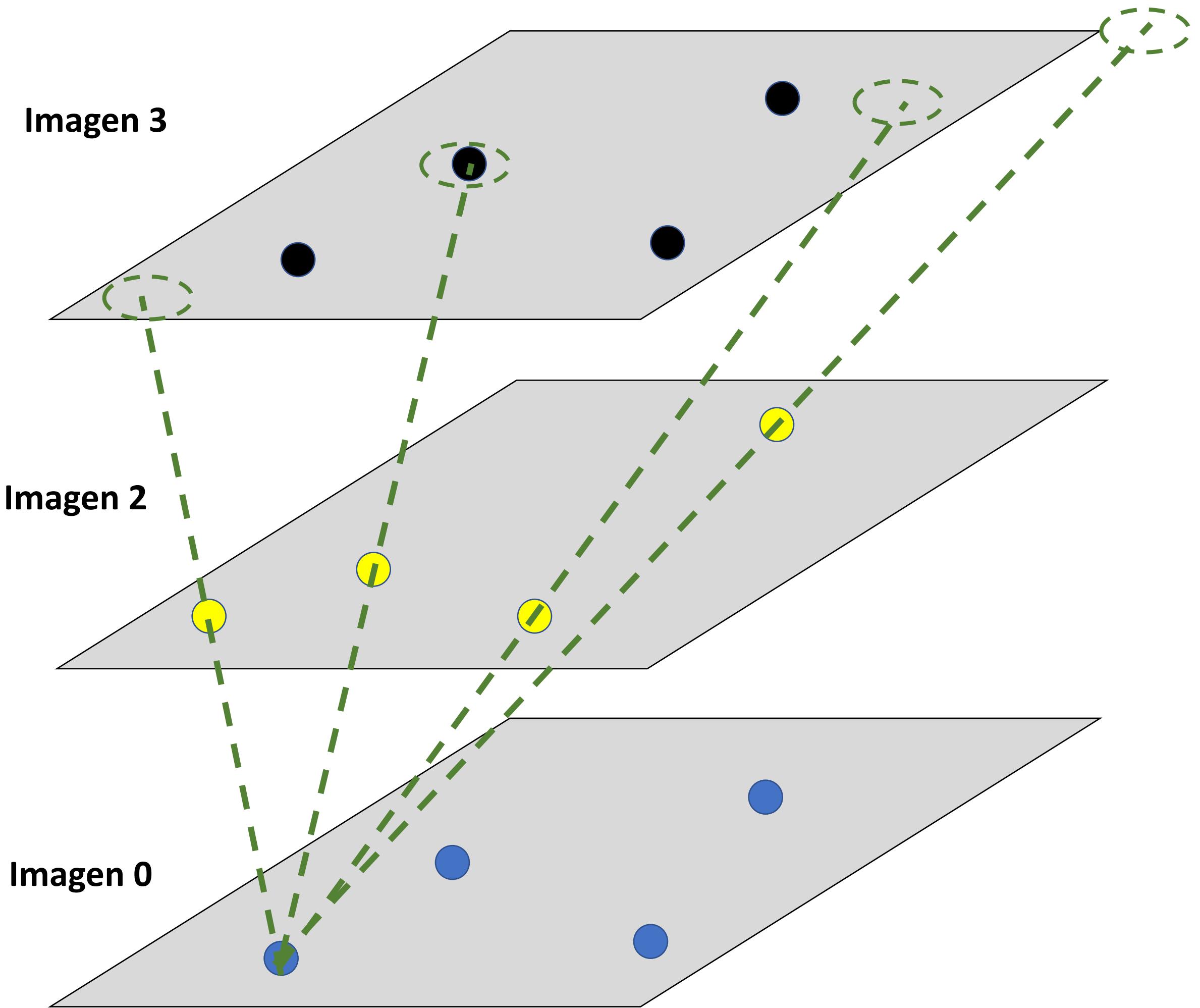


¿Pero cómo le enseñas a una computadora?

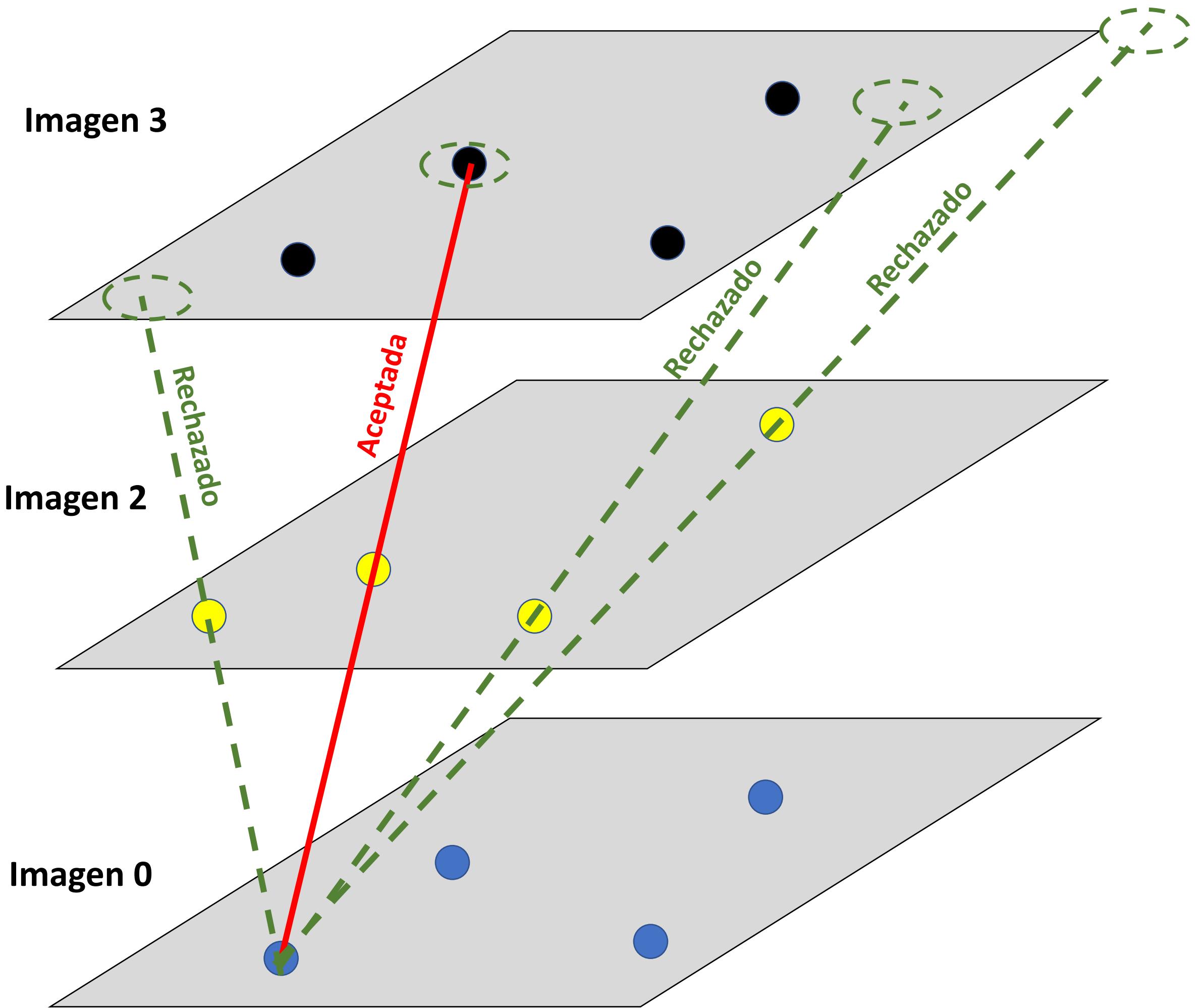
o8009g0075o.1299949.ch.1991737.XY51.p10
Time:2017-09-13T07:34:37.398042



¡La física tiene la respuesta!



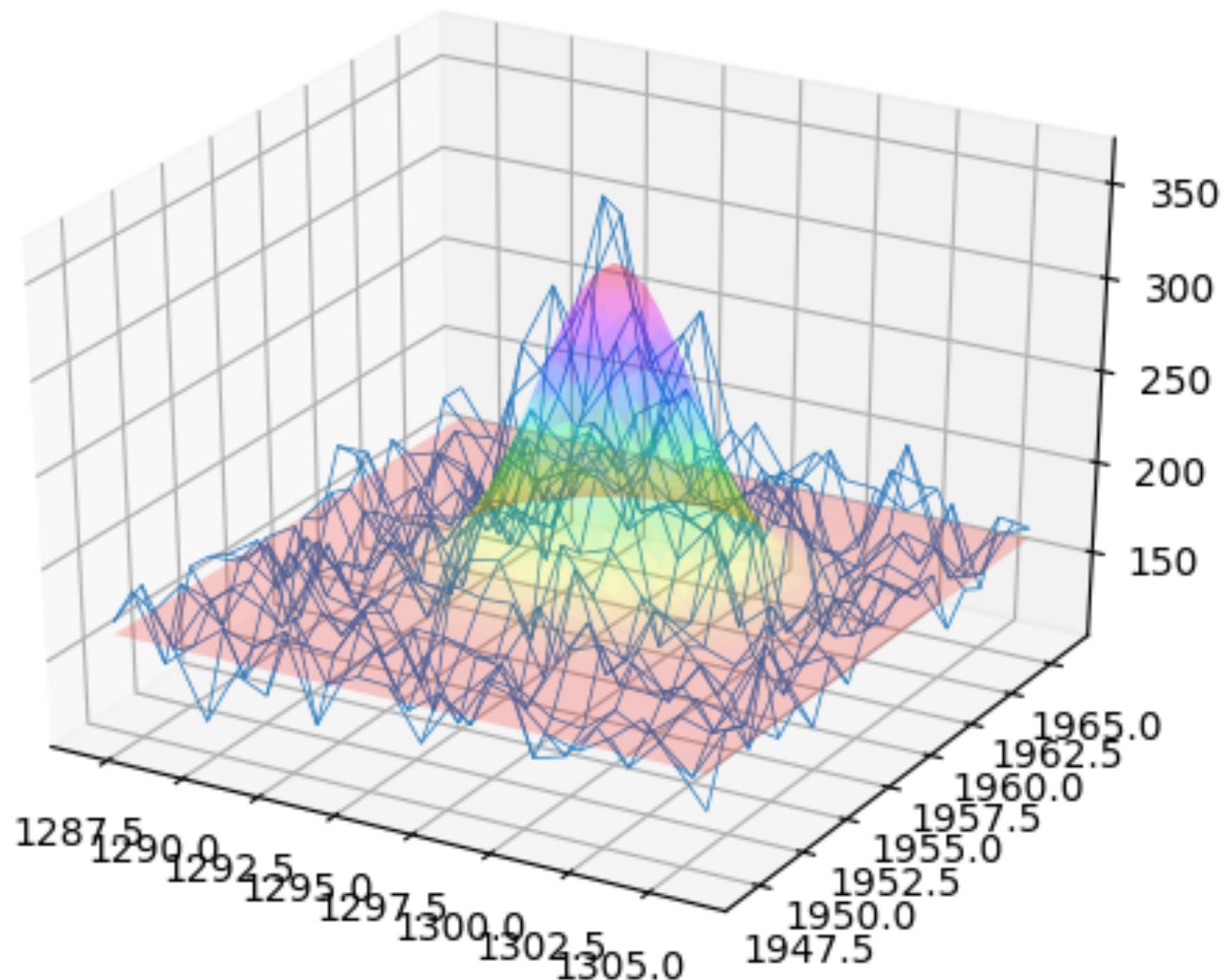
¡La física tiene la respuesta!



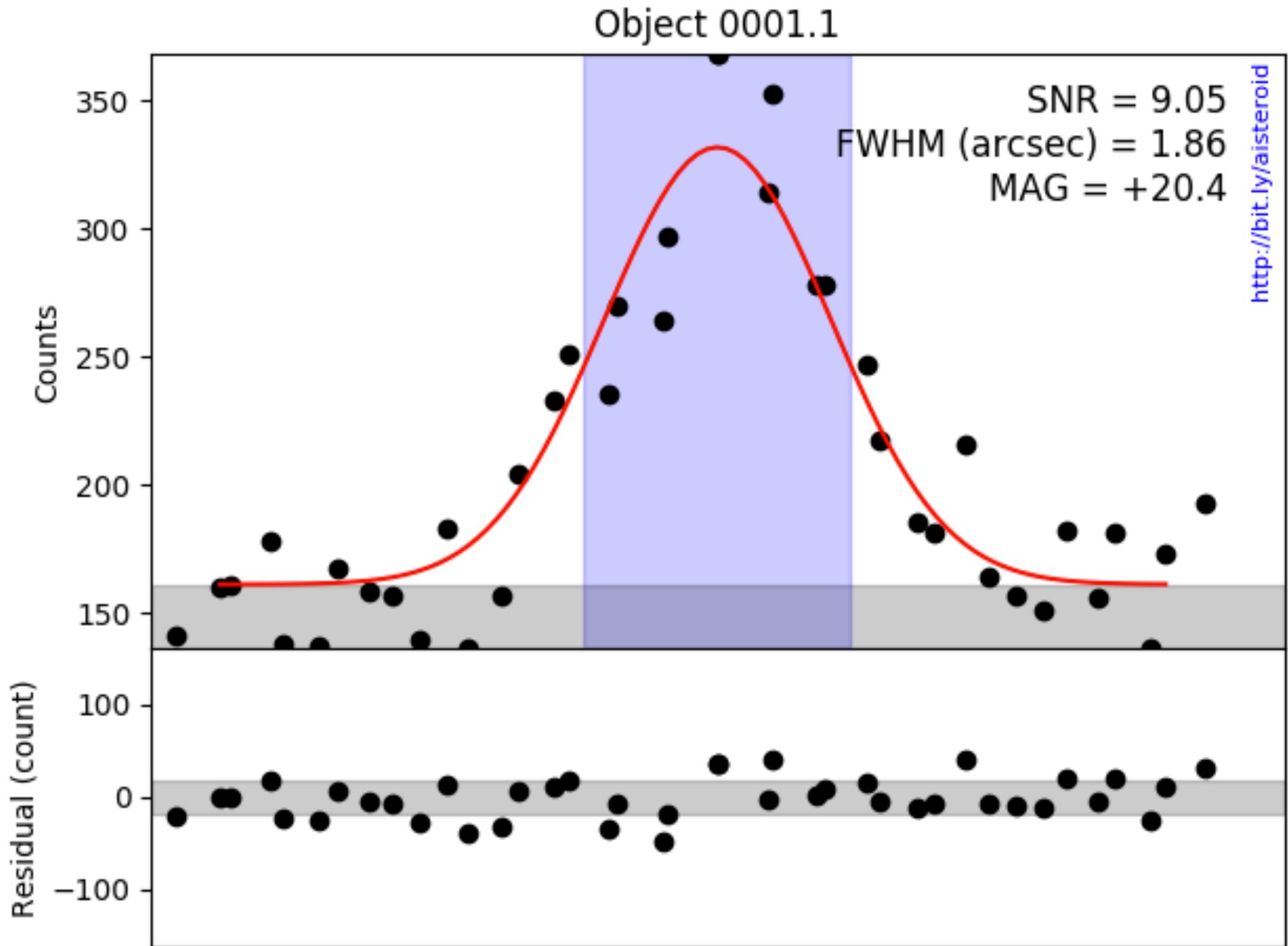
Hacer la fotometría
de los objetos

Ajustar la PSF

Object 1145, 0001.1, 2017-09-13T07:34:37.398042



Calcular la SNR y la magnitud



Hacer la lista de los
objetos detectados

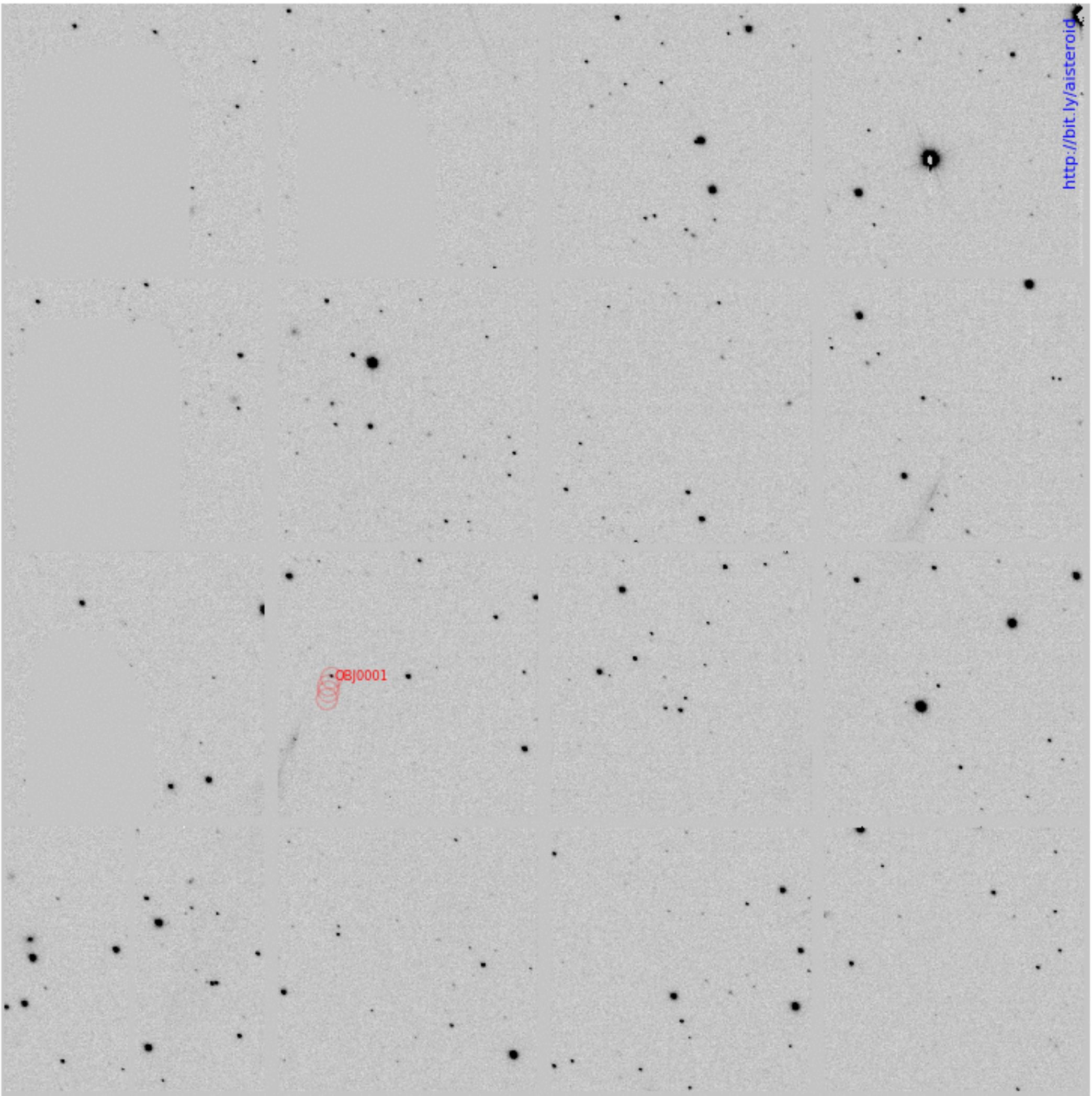
Lista en el formato del MPC Report

ID	REPORT										SNR	MAG_RANGE	
0001	C2017	09	13.31597121	03	57.218-15	33	48.33		20.4	R	F51	9.05	0.57
0001	C2017	09	13.32958521	03	56.806-15	33	45.99		20.7	R	F51	8.90	0.57
0001	C2017	09	13.34318521	03	56.390-15	33	43.74		20.7	R	F51	7.25	0.57
0001	C2017	09	13.35677121	03	55.981-15	33	41.24		21.0	R	F51	6.12	0.57
0002	C2017	09	13.31597121	04	14.345-15	33	49.24		19.6	R	F51	15.34	0.15
0002	C2017	09	13.32958521	04	14.006-15	33	51.28		19.8	R	F51	13.78	0.15
0002	C2017	09	13.34318521	04	13.676-15	33	53.58		19.6	R	F51	15.61	0.15
0002	C2017	09	13.35677121	04	13.341-15	33	55.57		19.6	R	F51	16.47	0.15
0003	C2017	09	13.31597121	03	57.103-15	31	45.76		21.3	R	F51	4.39	0.49
0003	C2017	09	13.32958521	03	56.749-15	31	47.78		21.8	R	F51	2.87	0.49
0003	C2017	09	13.34318521	03	56.409-15	31	50.07		21.6	R	F51	4.43	0.49
0004	C2017	09	13.31597121	04	12.125-15	31	24.90		20.2	R	F51	9.85	0.12
0004	C2017	09	13.32958521	04	11.668-15	31	26.72		20.2	R	F51	9.63	0.12
0004	C2017	09	13.34318521	04	11.211-15	31	28.68		20.2	R	F51	12.19	0.12
0004	C2017	09	13.35677121	04	10.756-15	31	30.31		20.1	R	F51	11.11	0.12
0005	C2017	09	13.31597121	03	57.085-15	30	1.11		19.3	R	F51	20.12	0.09
0005	C2017	09	13.32958521	03	56.716-15	30	4.57		19.3	R	F51	21.31	0.09
0005	C2017	09	13.34318521	03	56.347-15	30	8.01		19.2	R	F51	20.05	0.09
0005	C2017	09	13.35677121	03	55.980-15	30	11.33		19.3	R	F51	19.50	0.09

Ejemplos

Objetos muy brillantes

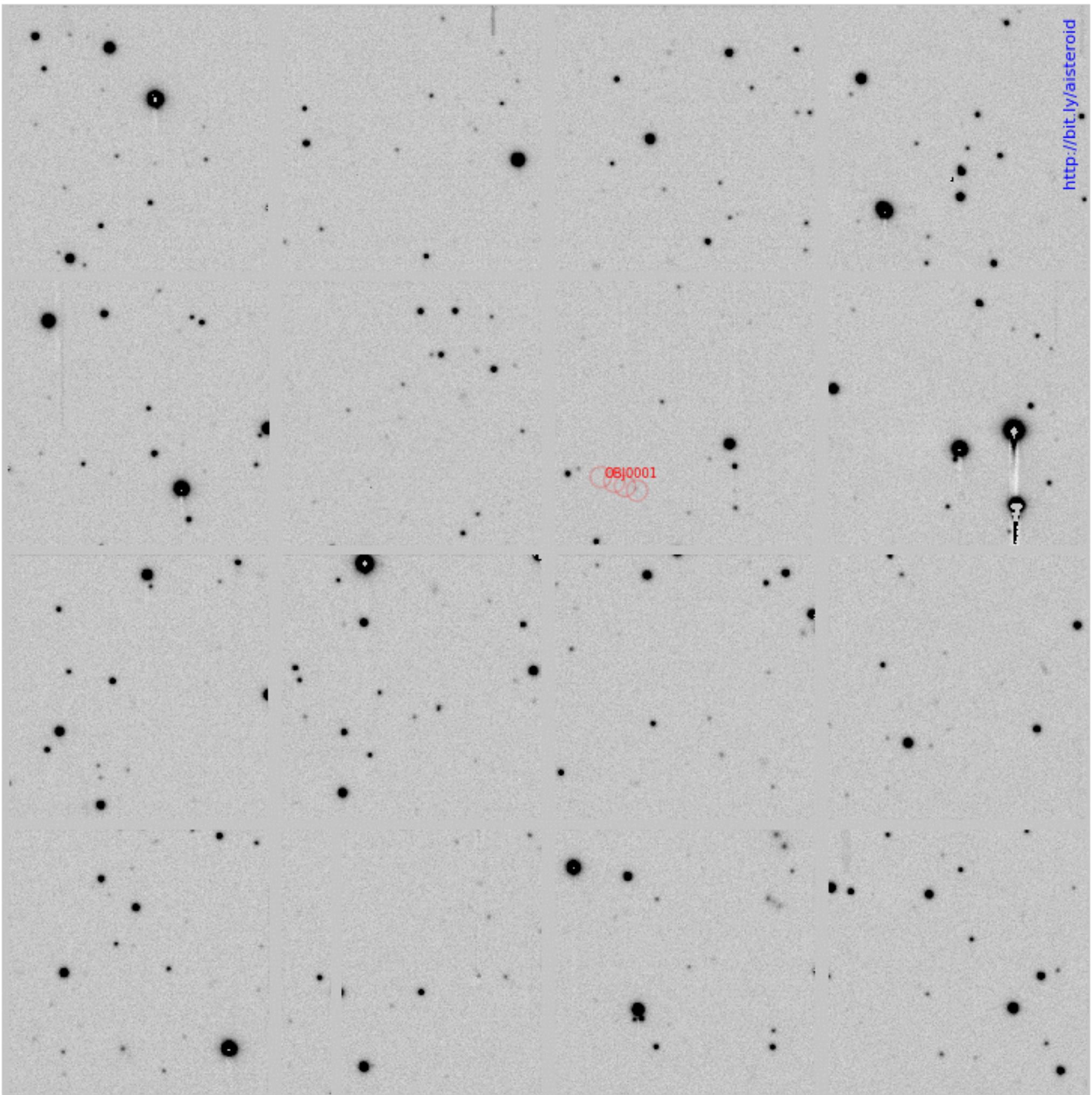
Set ps1-20170913_1_set140, Image 0: 2017-09-13T07:34:37.398042



<http://bit.ly/asteroid>

Objetos muy débiles

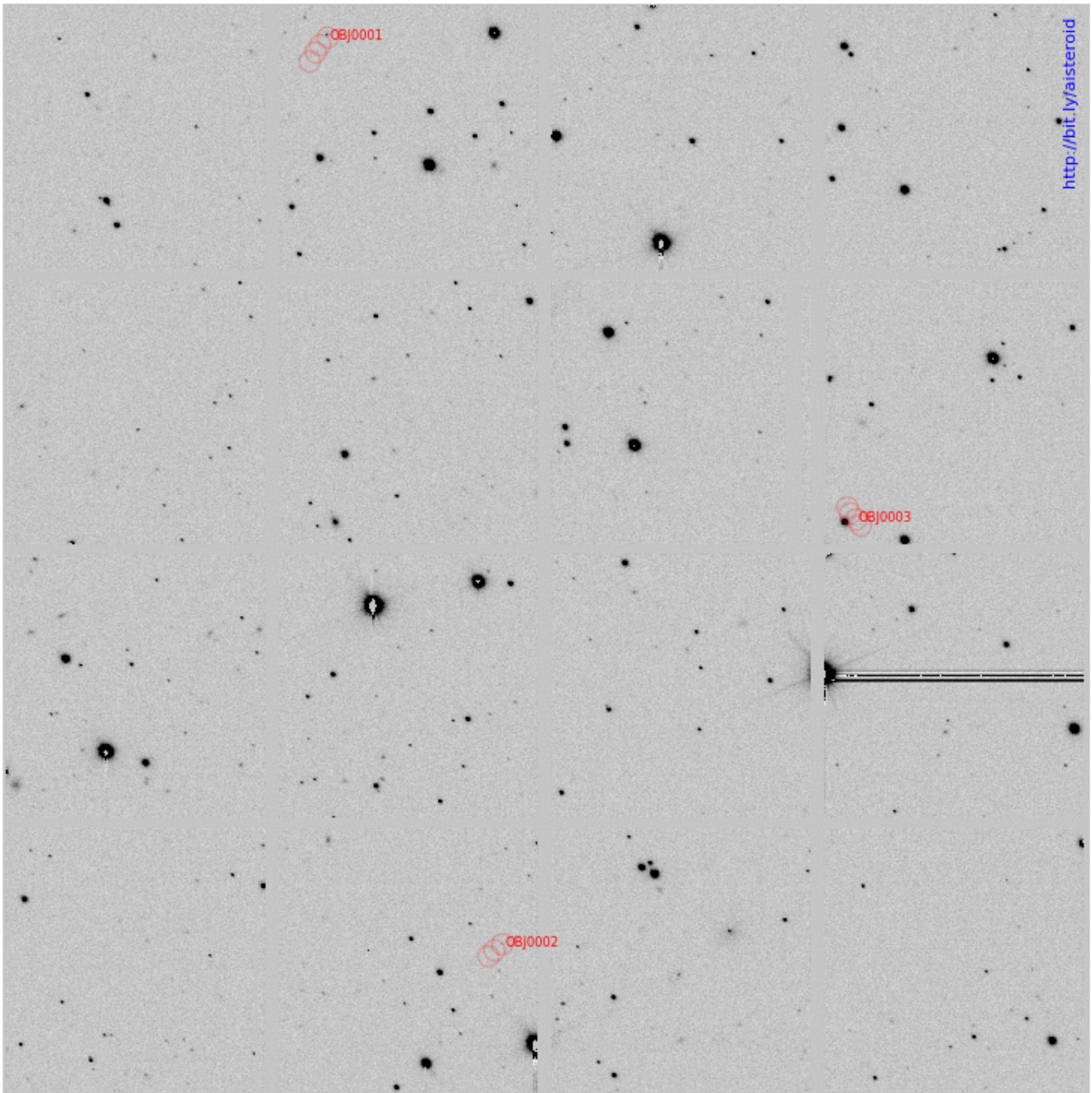
Set ps1-20180108_3_set083, Image 0: 2018-01-08T08:44:32.464539



<http://bit.ly/asteroid>

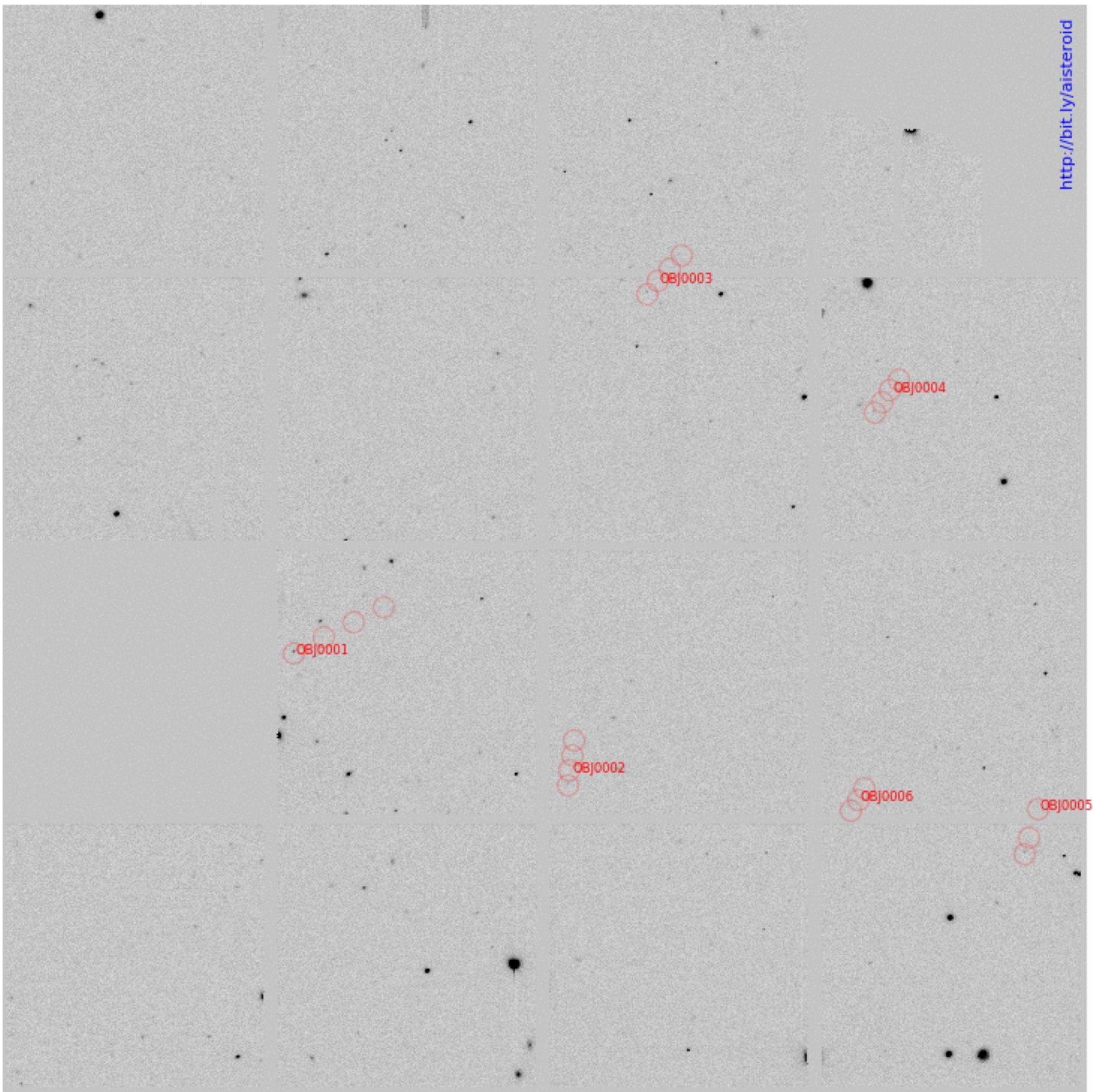
Detección múltiple

Set ps1-20170913_1_set141, Image 0: 2017-09-13T07:34:37.398042



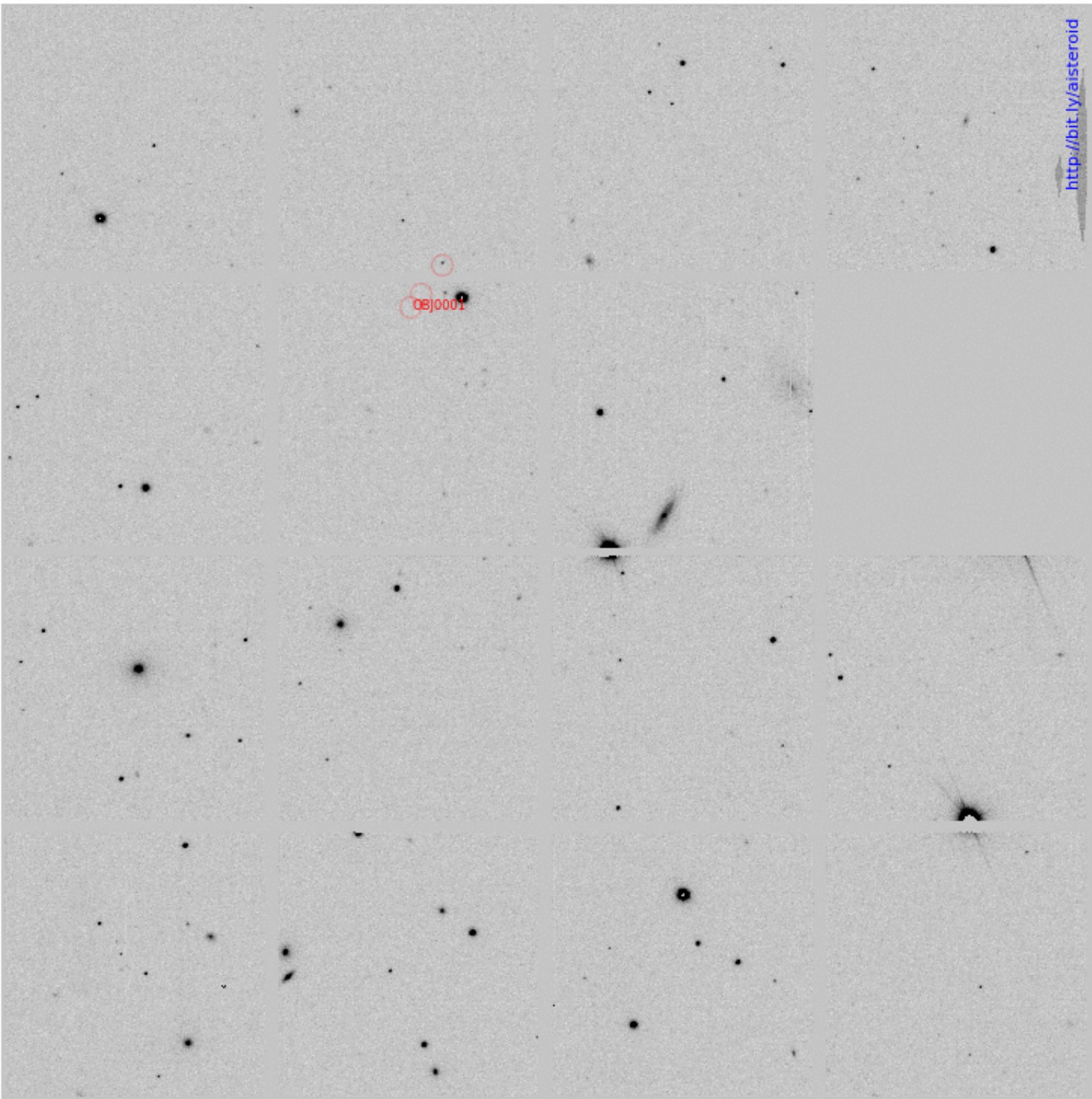
¿Pasa la prueba del IASC?

Set ps1-20170914_4_set096, Image 0: 2017-09-14T09:54:45.670299



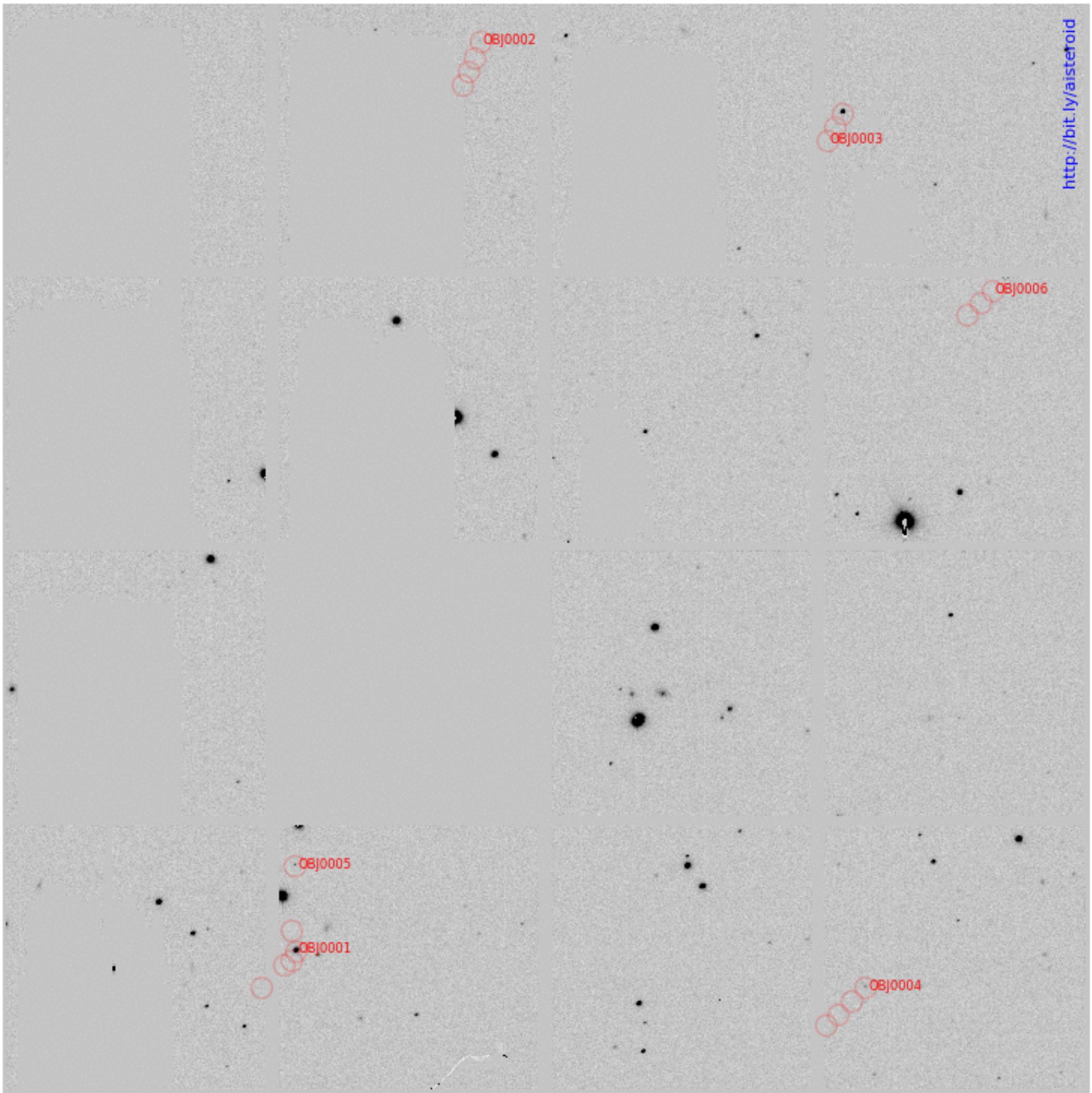
Desapariciones temporales

Set ps1-20170914_4_set105, Image 0: 2017-09-14T09:54:45.670299



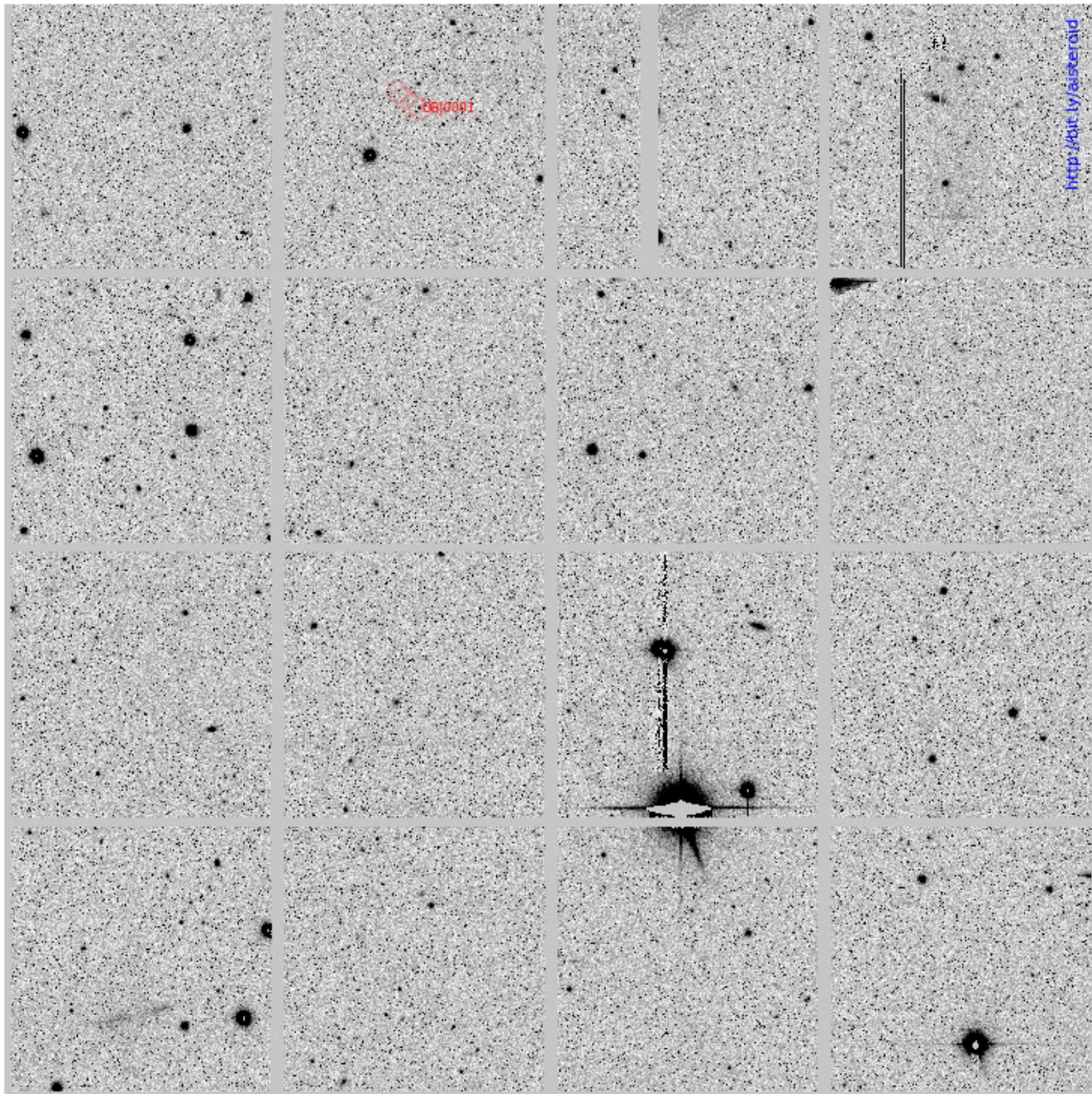
Objetos que se cruzan

Set ps1-20170914_11_set176, Image 0: 2017-09-14T09:53:47.319567



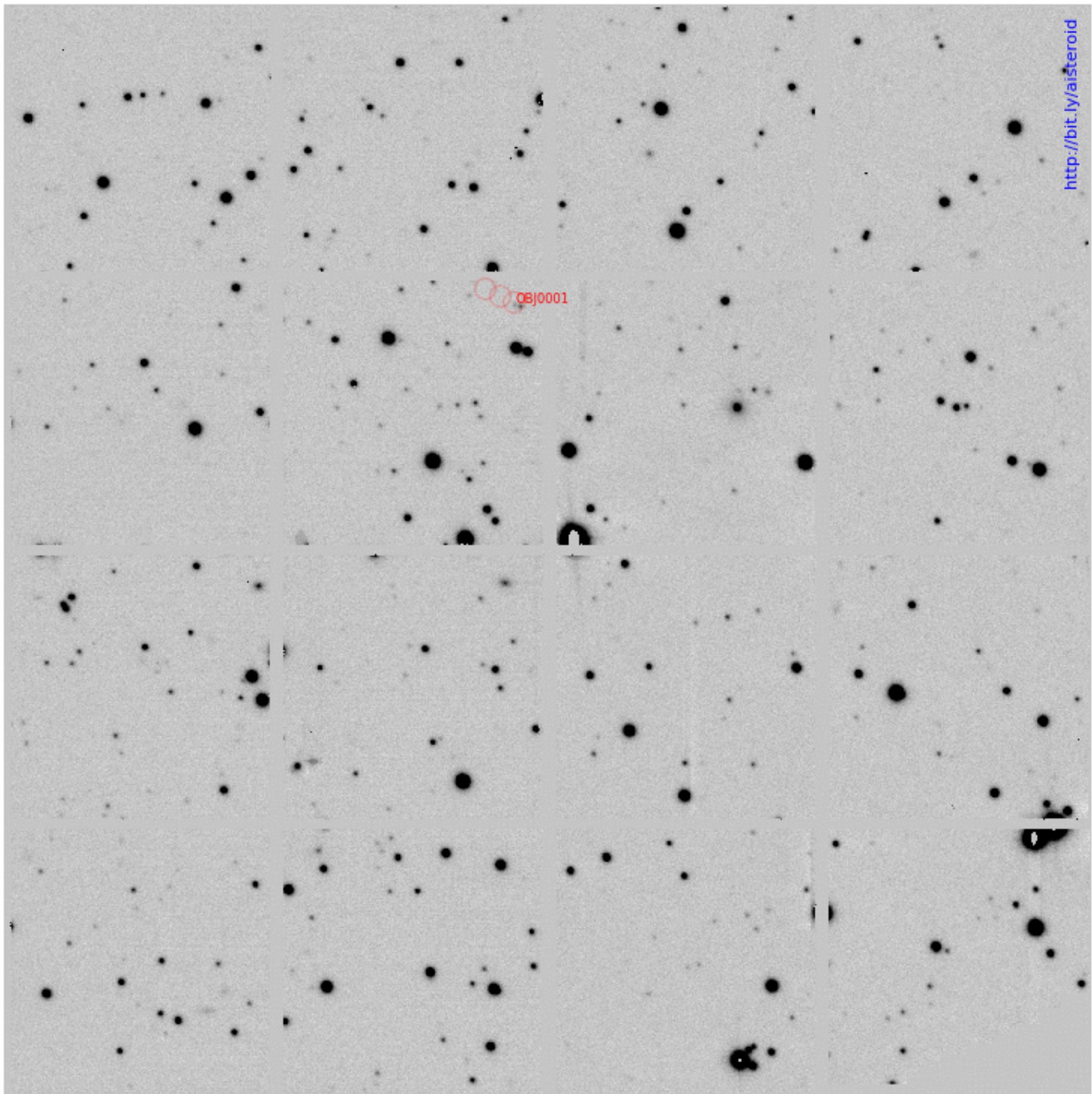
En “terreno destapado”

Set ps1-20180107_1_set030, Image 0: 2018-01-07T06:44:20.991472



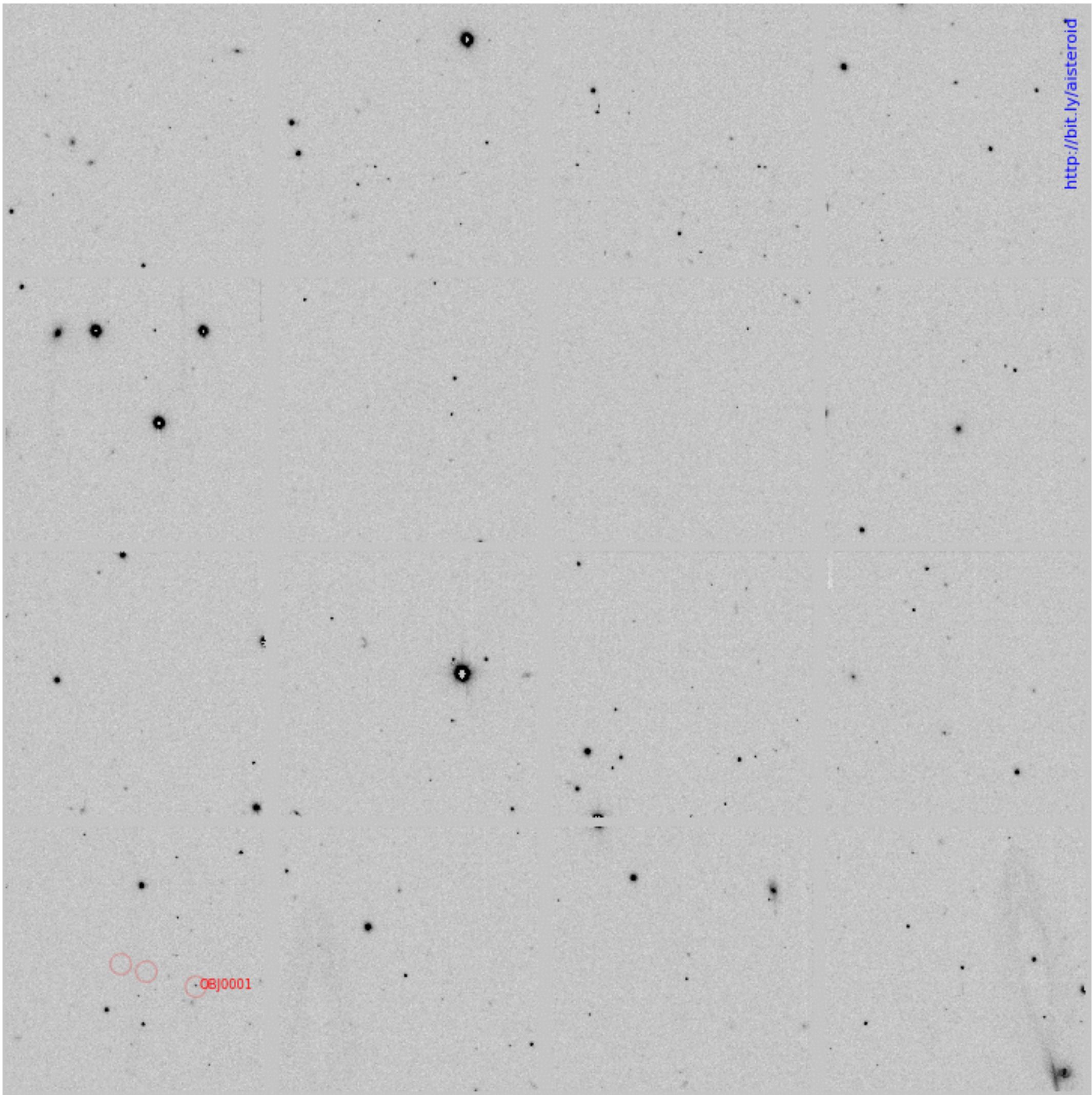
En “terreno destapado”

Set ps1-20180108_2_set167, Image 0: 2018-01-08T08:42:41.172957



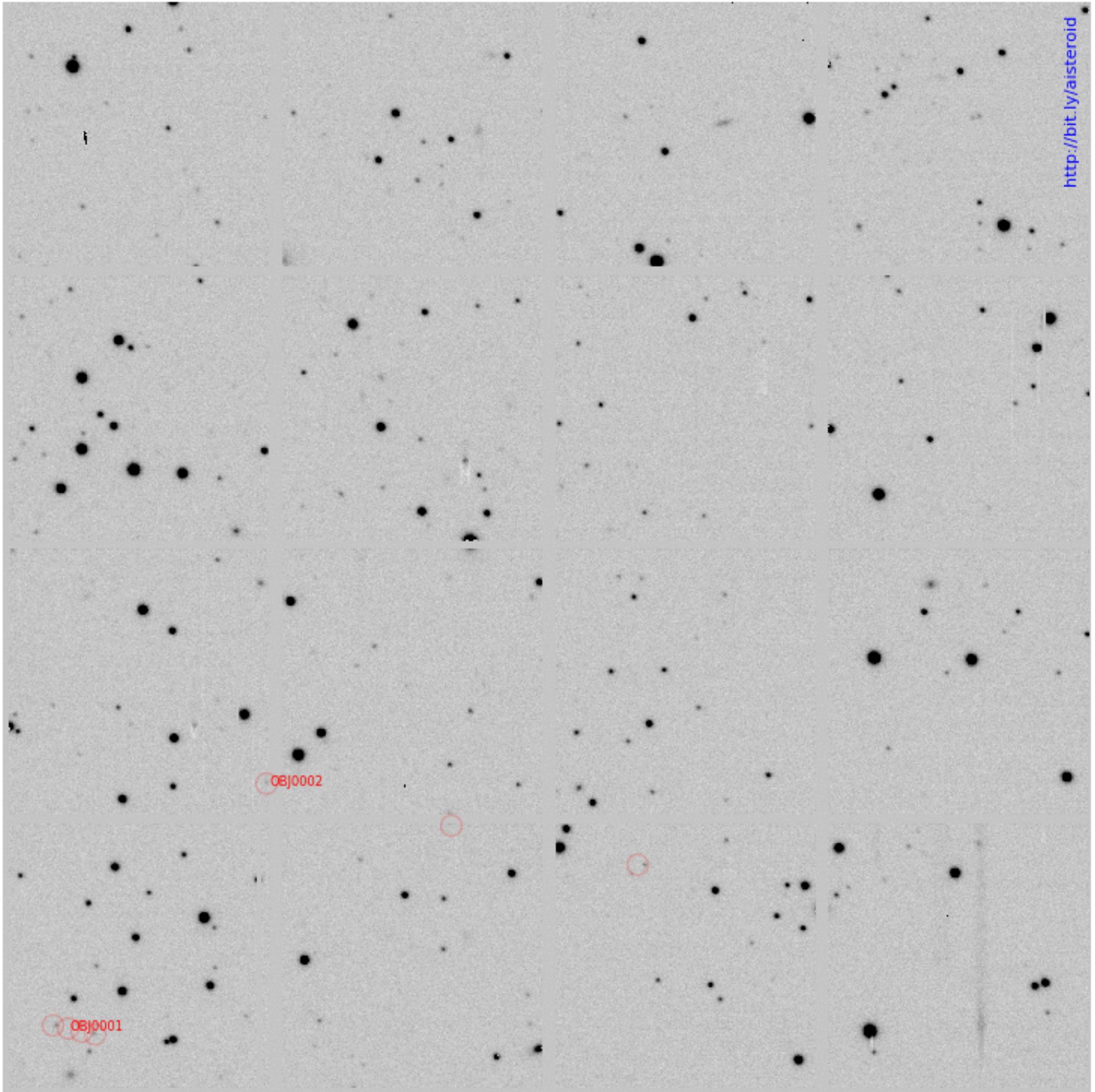
Tránsitos

Set ps1-20180107_1_set076, Image 0: 2018-01-07T06:44:20.991472



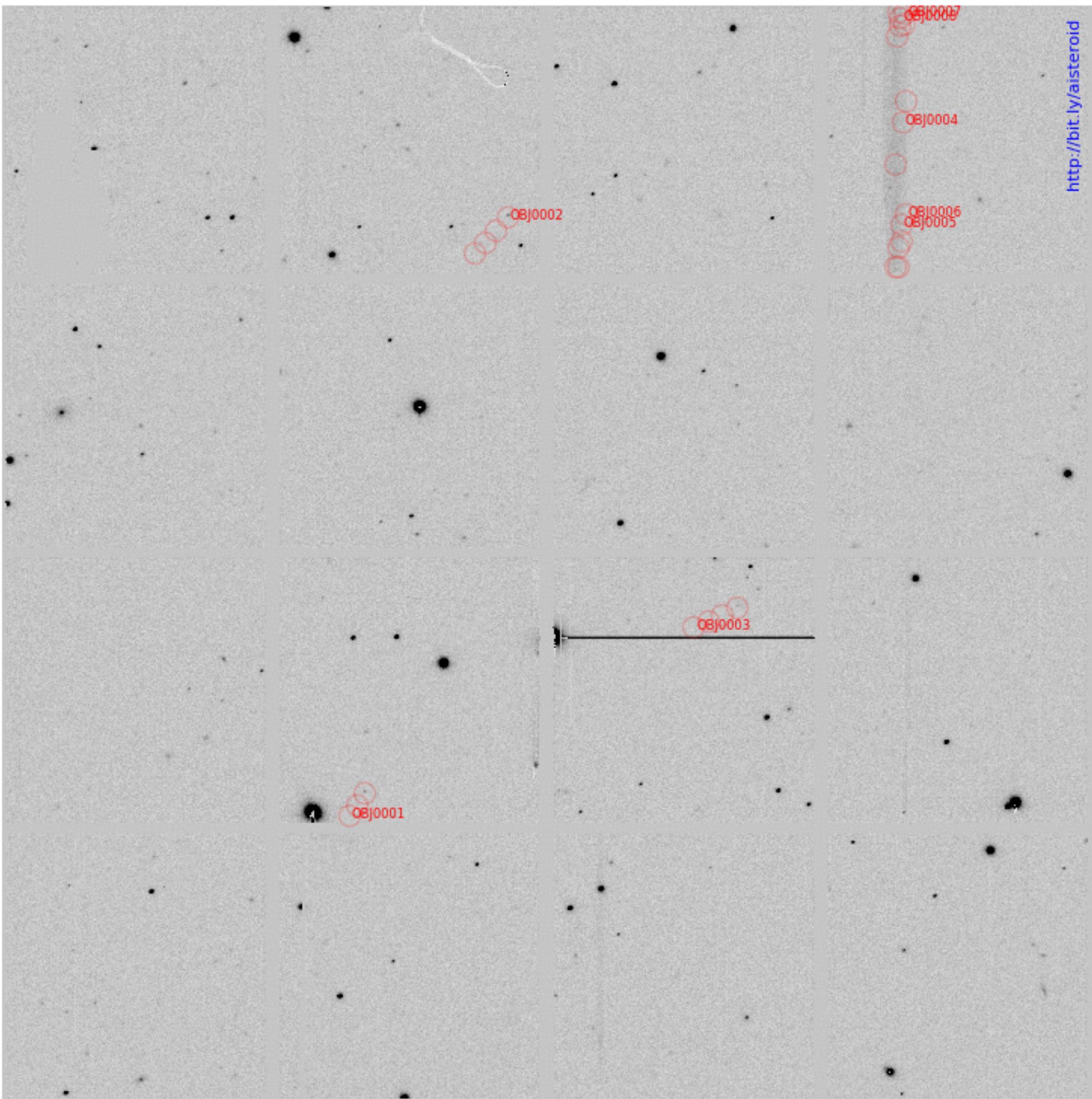
Tránsitos

Set ps1-20180108_3_set018, Image 0: 2018-01-08T08:44:32.464539



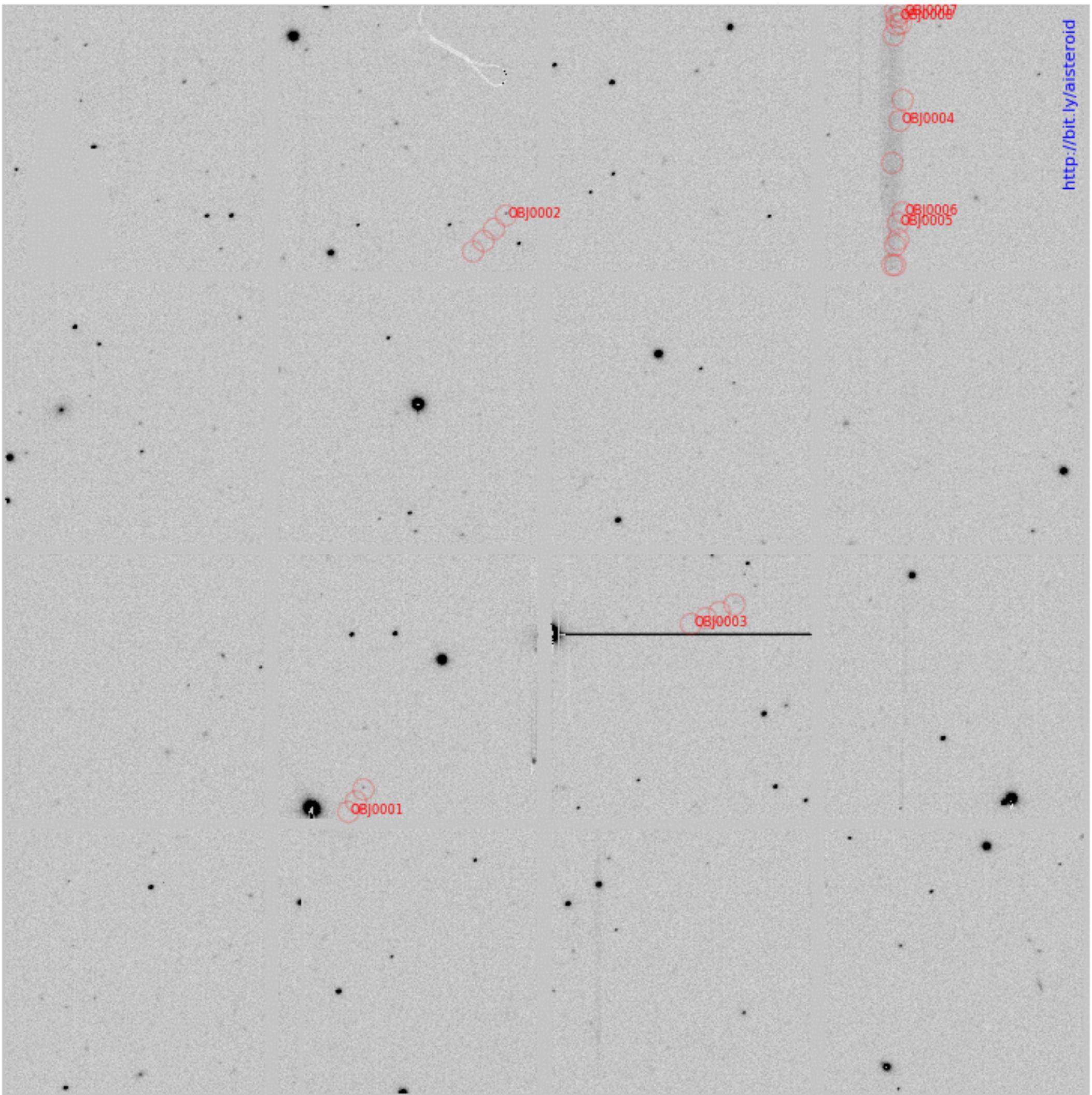
Falsos positivos

Set ps1-20170914_11_set177, Image 0: 2017-09-14T09:53:47.319567



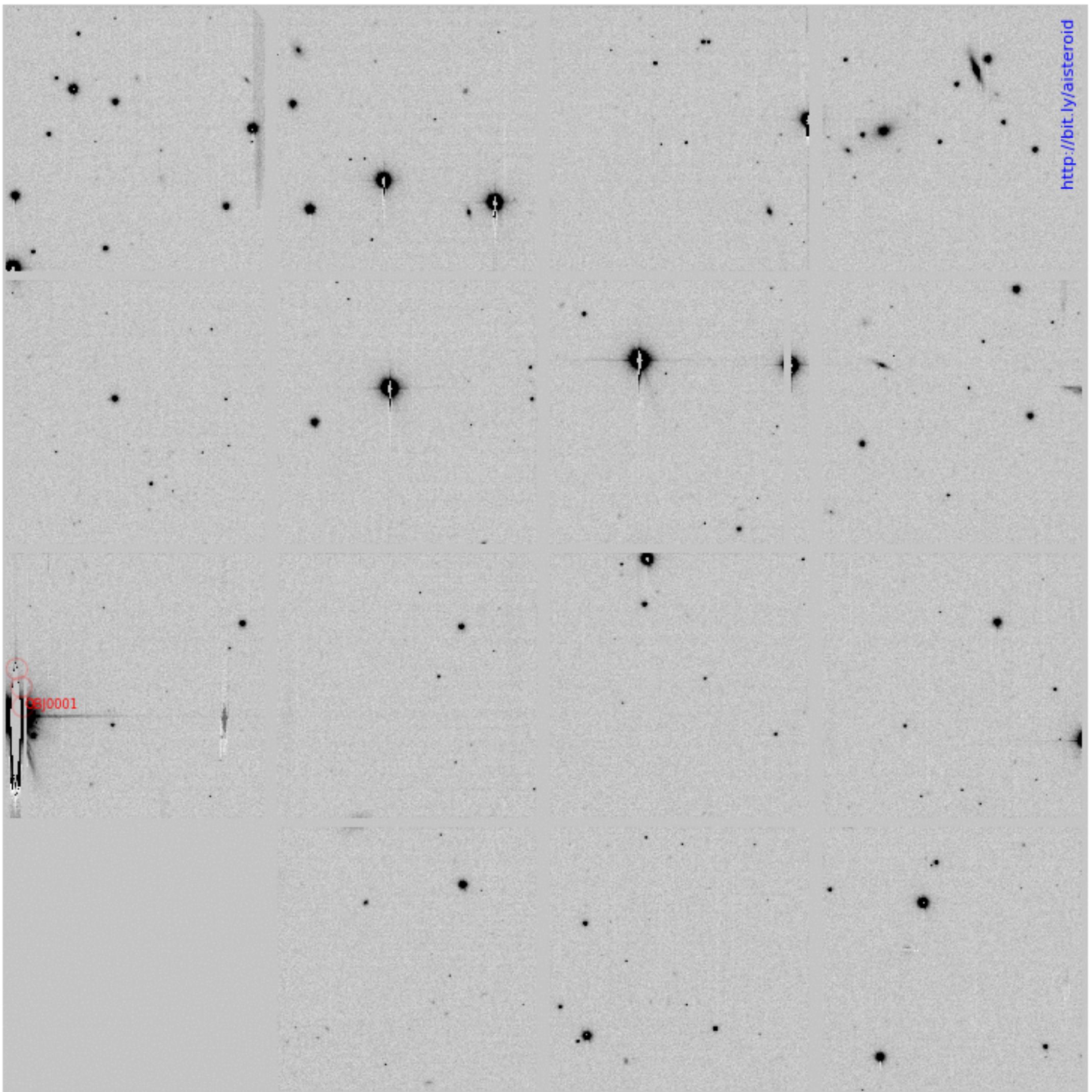
Falsos positivos

Set ps1-20170914_11_set177, Image 0: 2017-09-14T09:53:47.319567



Falsos positivos

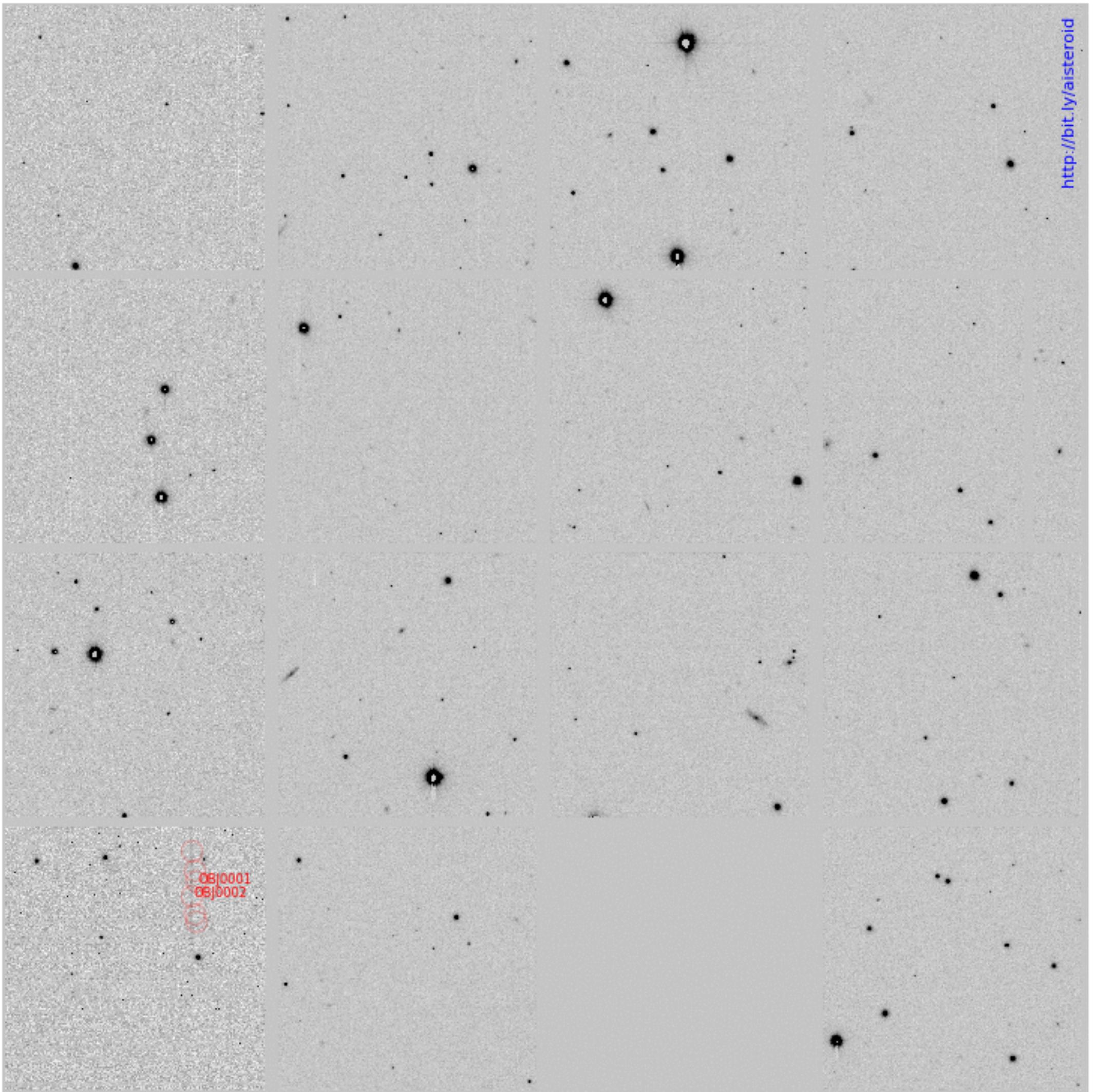
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<http://bit.ly/aistroid>

Falsos positivos

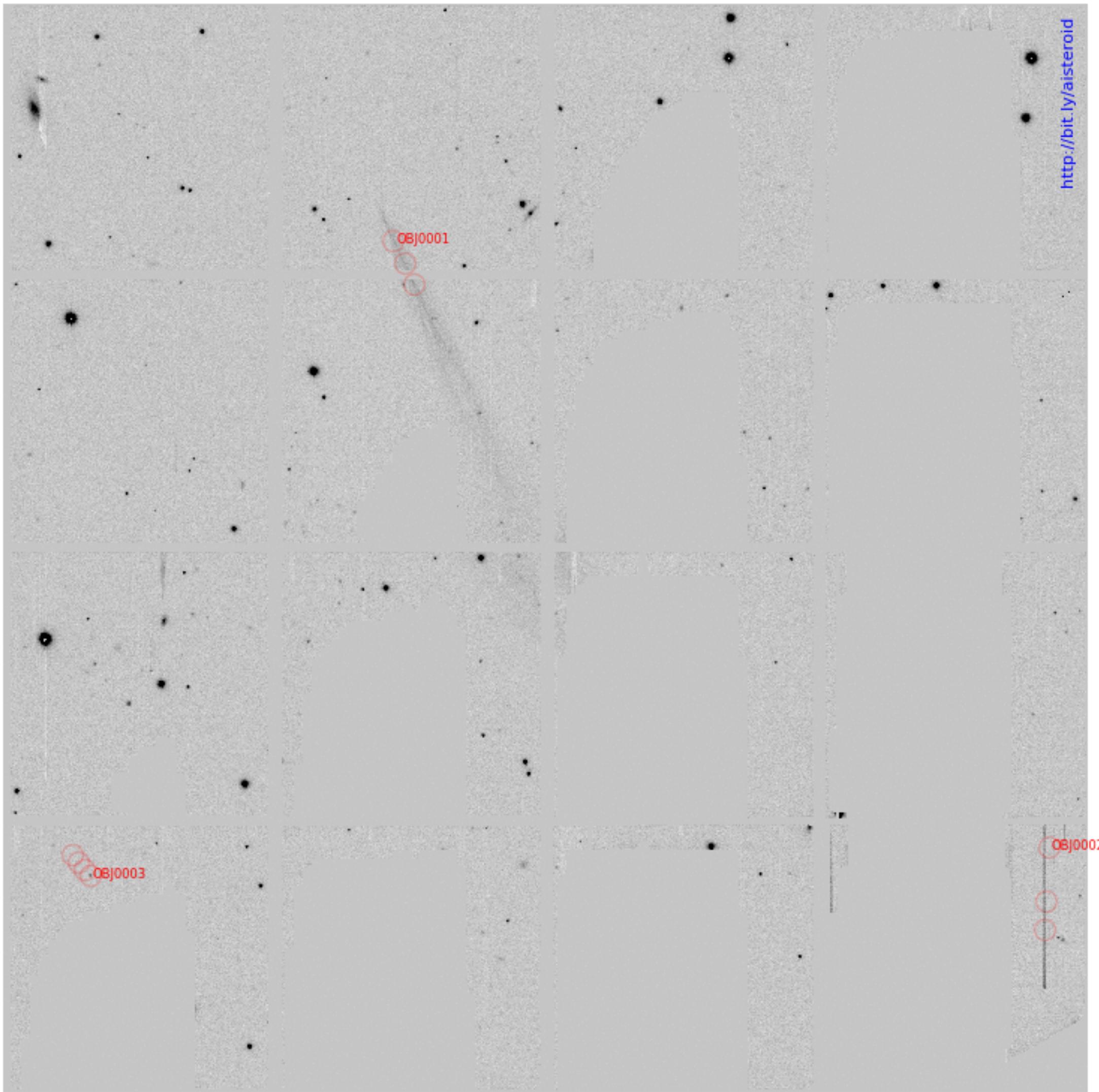
Set ps1-20180107_1_set033, Image 0: 2018-01-07T06:44:20.991472



<http://bit.ly/asteroid>

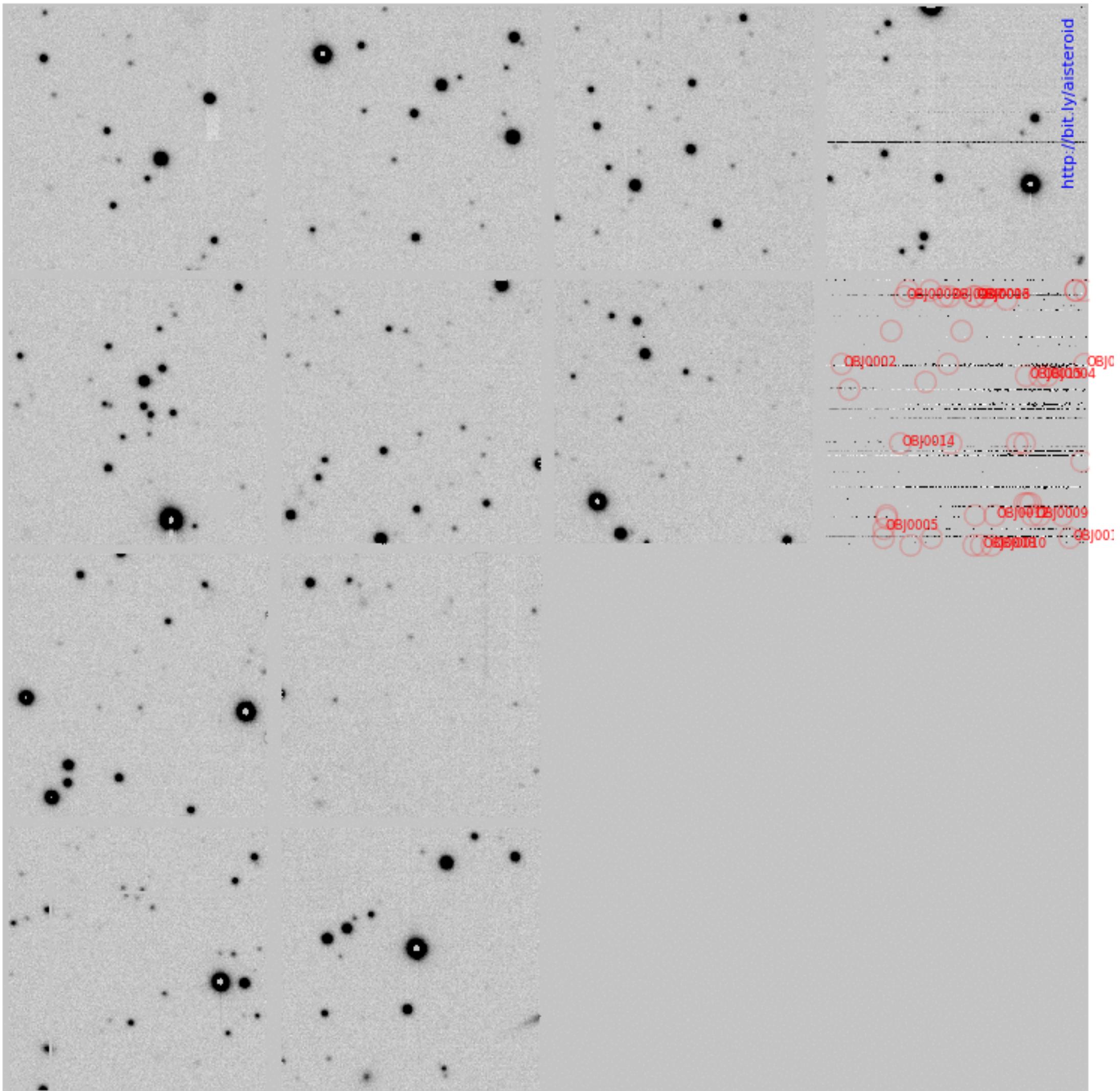
Falsos positivos

Set ps1-20180107_1_set043, Image 0: 2018-01-07T06:44:20.991472



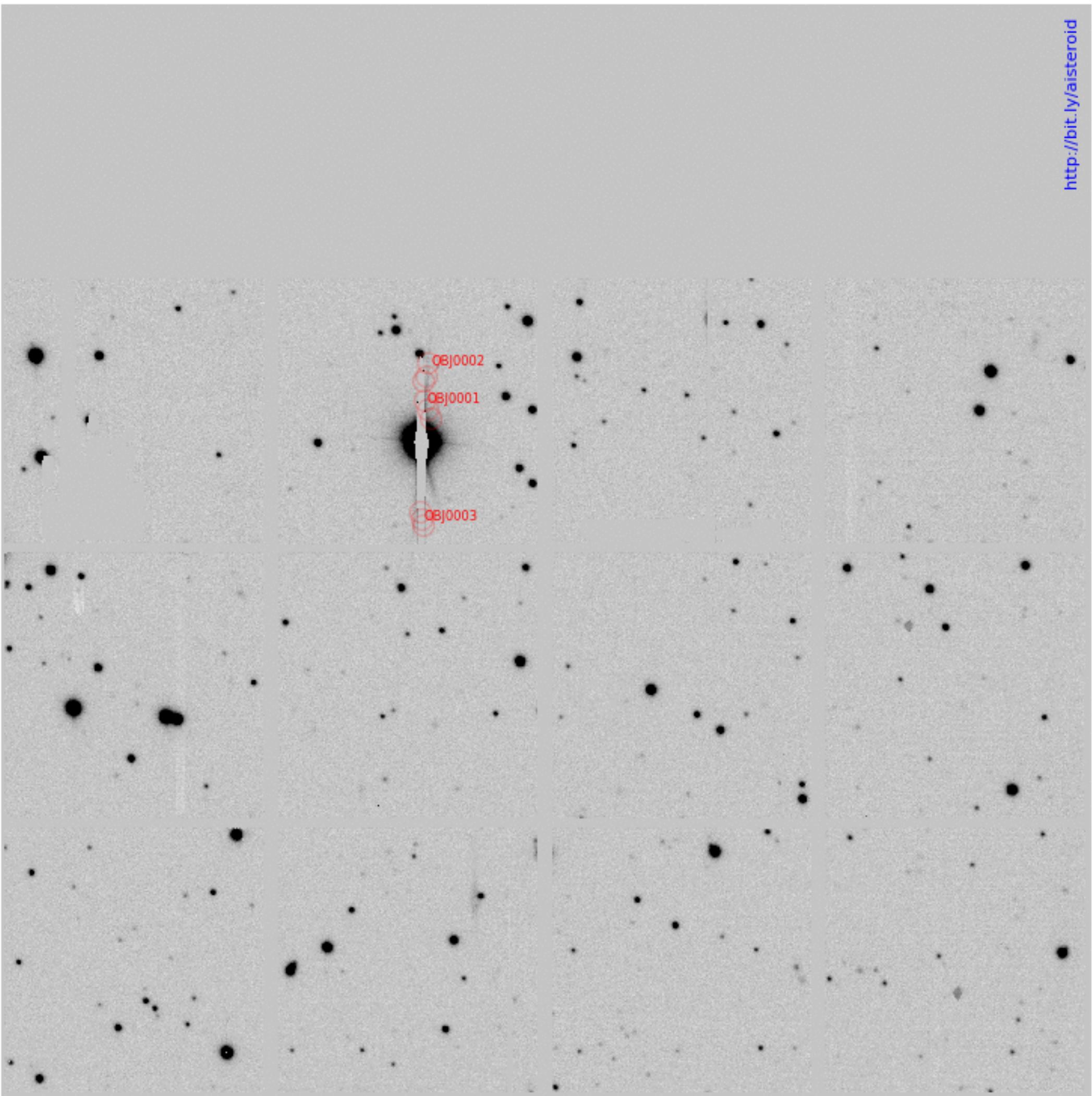
Falsos positivos

Set ps1-20180108_2_set191, Image 0: 2018-01-08T08:42:41.172957



Falsos positivos

Set ps1-20180108_3_set100, Image 0: 2018-01-08T08:44:32.464539

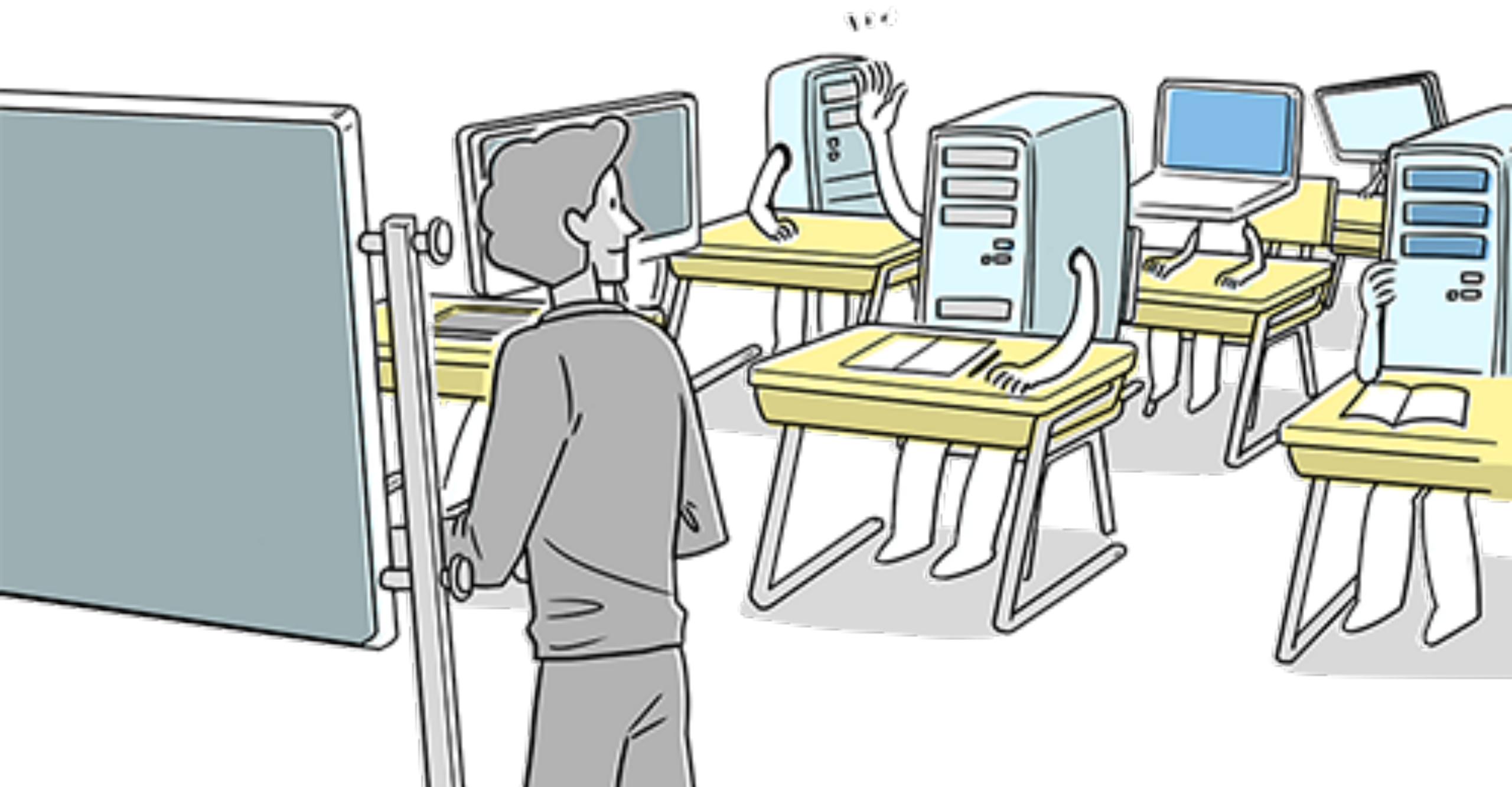


Entonces...

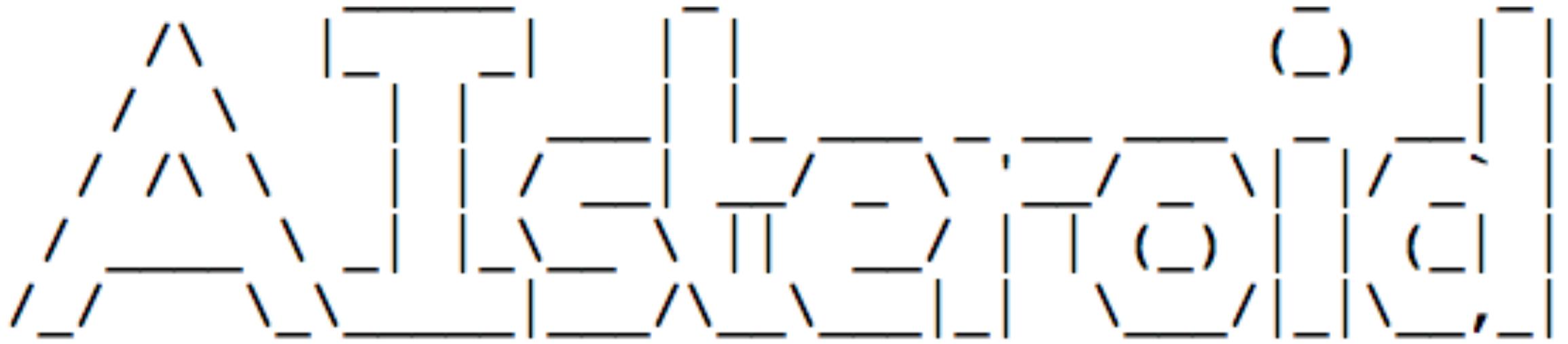
¿Ya no hacen falta estos para buscar asteroides?



*Si, ¡hacen falta!**



**pero no necesariamente cumpliendo el mismo rol*



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