

# FlakeAutoFind

## Computer Vision Processing of Microscopy Photos

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Edge Detection, Contouring, and Transmission

Measurement (partial)

# Flattening

Assuming elliptical symmetry, we define a distance metric

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Sampling multiple points, we then obtain a system of linear equations in  $a_n$

$$B_i = \sum_n a_n s_i^{2n}$$

## Flattening

Rewrite the previous as matrix equation

$$B = SA$$

with the vector of background values  $B_i$  being measured at points  $s_i$  to generate  $S_{ij} = s_i^{2(j-1)}$ , with coefficients  $A_n = a_n$

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We strategically chose  $s_i$  to make computation easy:

$$s_i^2 = (i + 1) \cdot s^2$$

and suppress powers of  $s^2$  in the final matrix.

## Flattening

Performing row reduction on  $S$ , we obtain a nice pattern:

$$[S'|I] = \left[ \begin{array}{cccc|c|ccccc} 1 & 1 & 1 & 1 & \cdots & 1 & 0 & 0 & 0 & \cdots \\ 1 & 2 & 4 & 8 & \cdots & 0 & 1 & 0 & 0 & \cdots \\ 1 & 3 & 9 & 27 & \cdots & 0 & 0 & 1 & 0 & \cdots \\ 1 & 4 & 16 & 64 & \cdots & 0 & 0 & 0 & 1 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \ddots \end{array} \right]$$



$$[T|C] = \left[ \begin{array}{cccc|c|ccccc} 1 & 1 & 1 & 1 & \cdots & 1 & 0 & 0 & 0 & \cdots \\ 0 & 1 & 3 & 7 & \cdots & -1 & 1 & 0 & 0 & \cdots \\ 0 & 0 & 2 & 12 & \cdots & 1 & -2 & 1 & 0 & \cdots \\ 0 & 0 & 0 & 6 & \cdots & -1 & 3 & -3 & 1 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots & \ddots \end{array} \right]$$

This pattern was calculated and verified to hold until at least  $n = 10$

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Thus, we can obtain  $A$  by instead solving the equation

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Once  $A$  is determined, the baseline approximation can be computed recursively as

$$f_0 = a_N$$

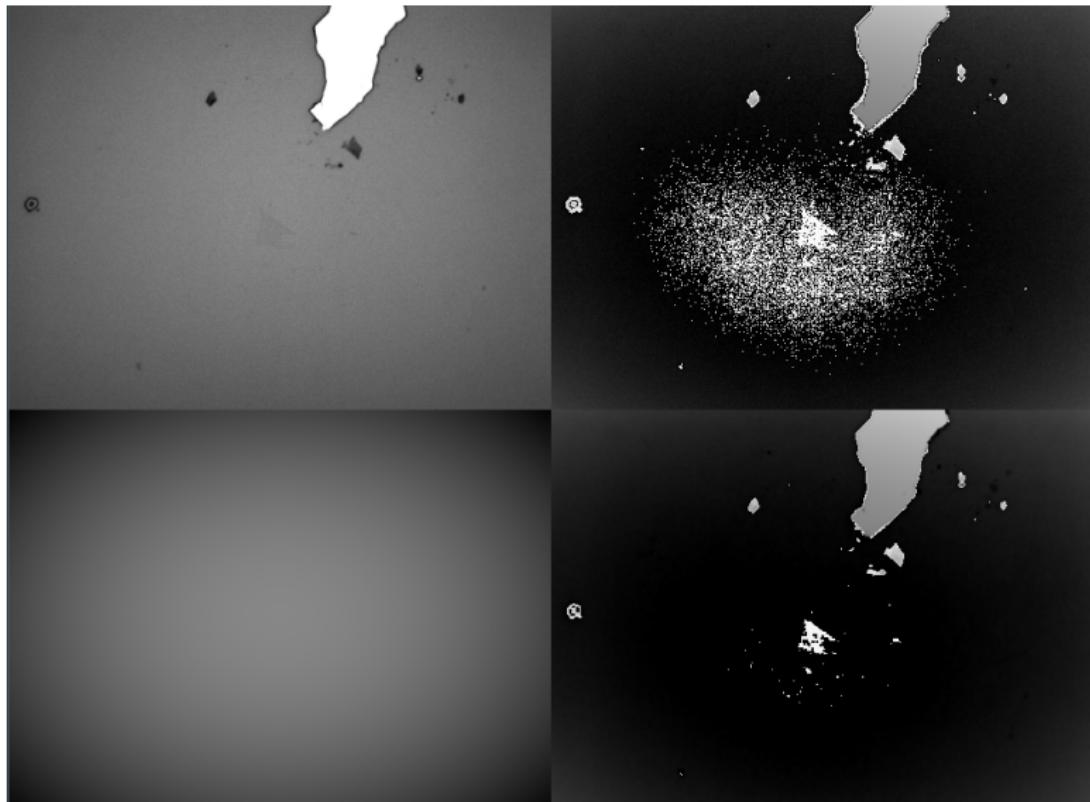
$$f_n = s^2 f_{n-1} + a_{N-n}$$

$$B_N(s) = f_N$$

This baseline is then subtracted from the total image. After flattening, the contrast may be increased to make flakes more apparent,

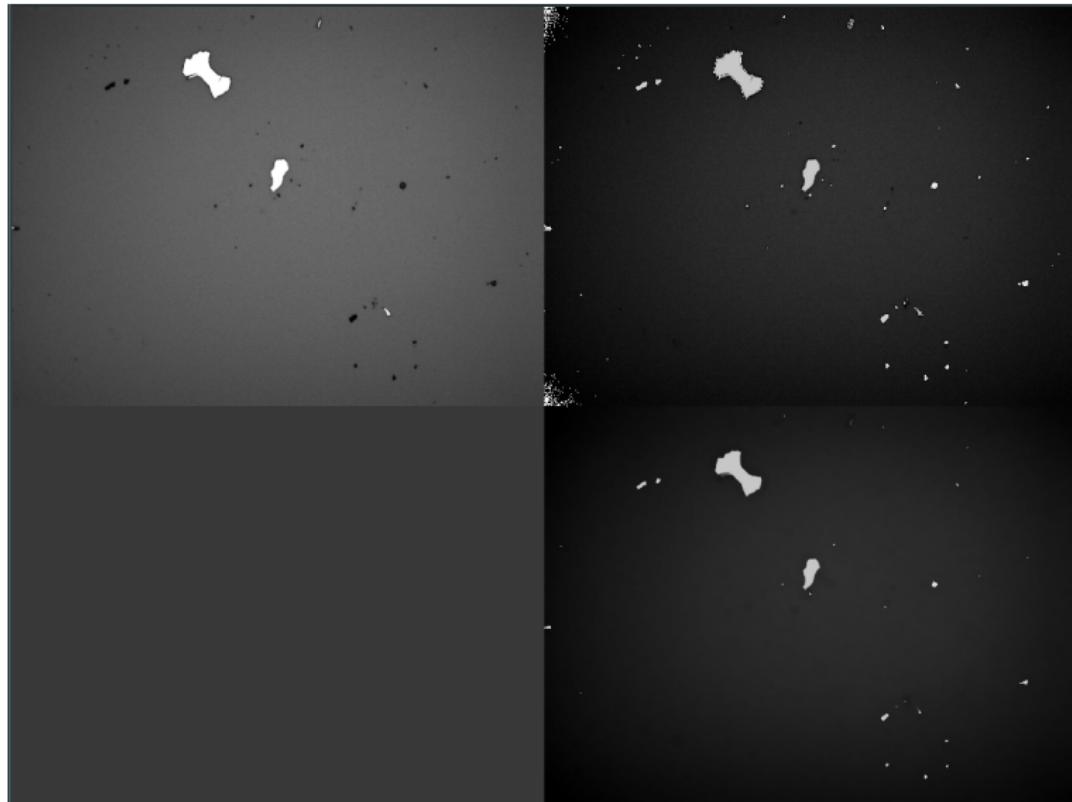
# Flattening Results

Initial test: 2 fixed points



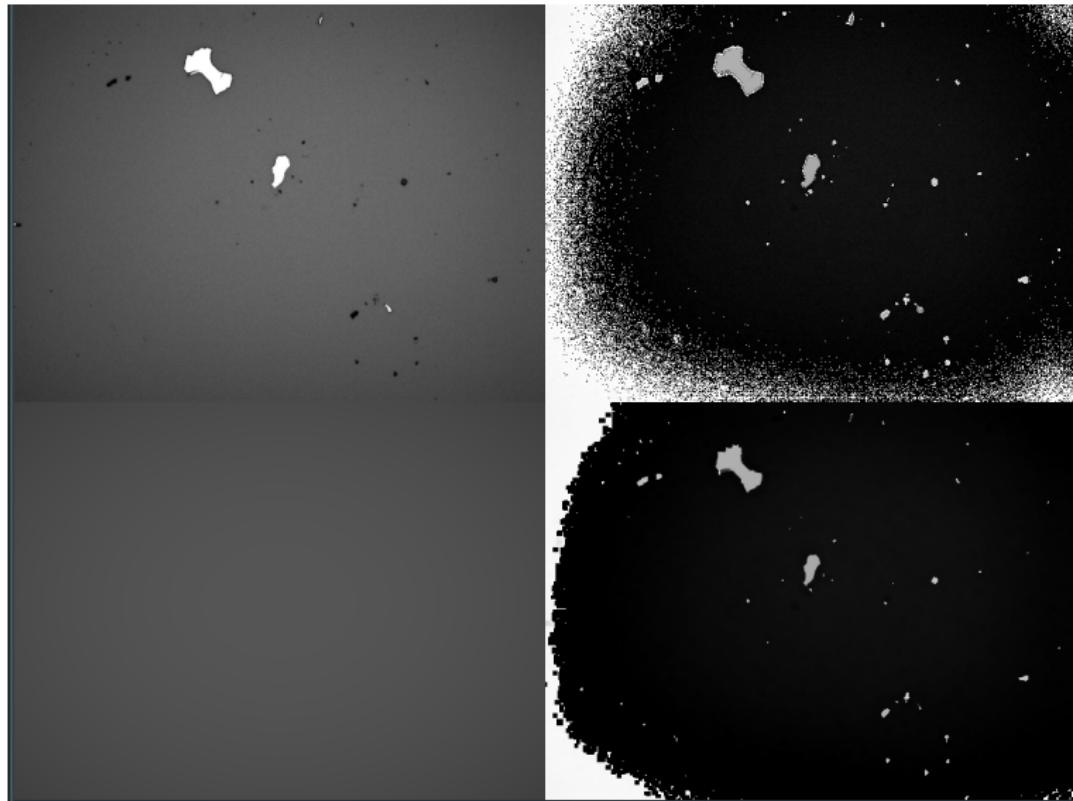
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General: 1 Sample



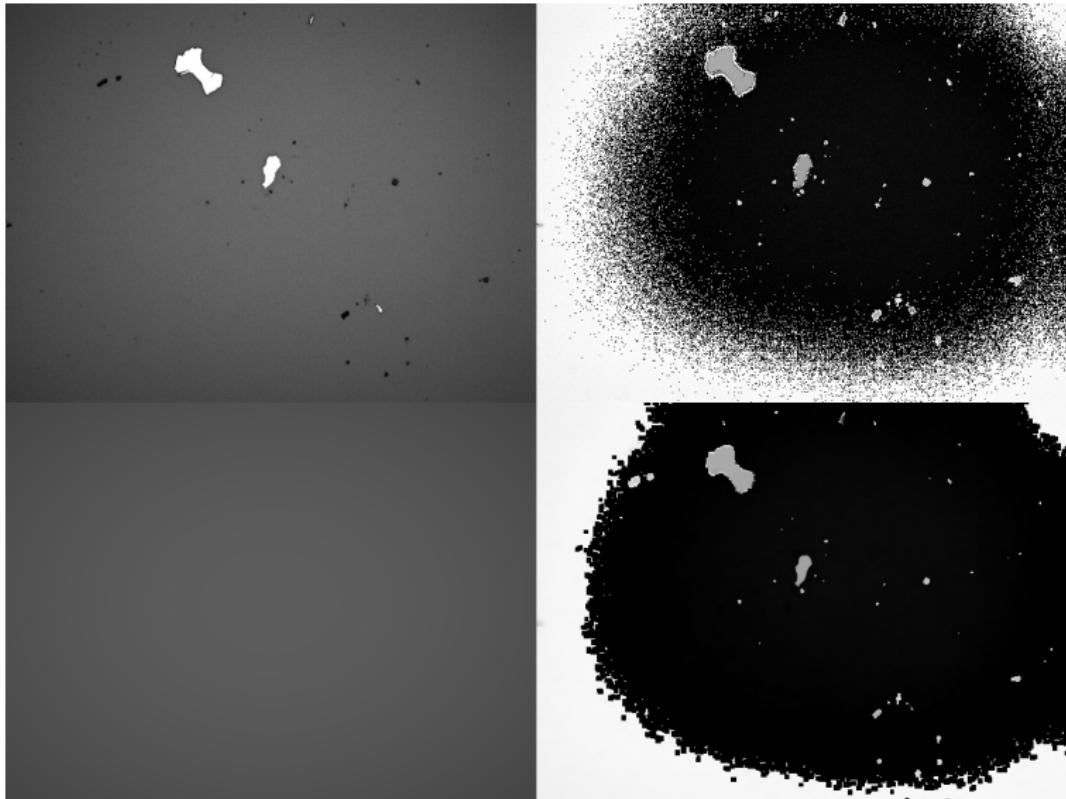
# Flattening Results

General: 3 Sample



# Flattening Results

General: 5 Sample



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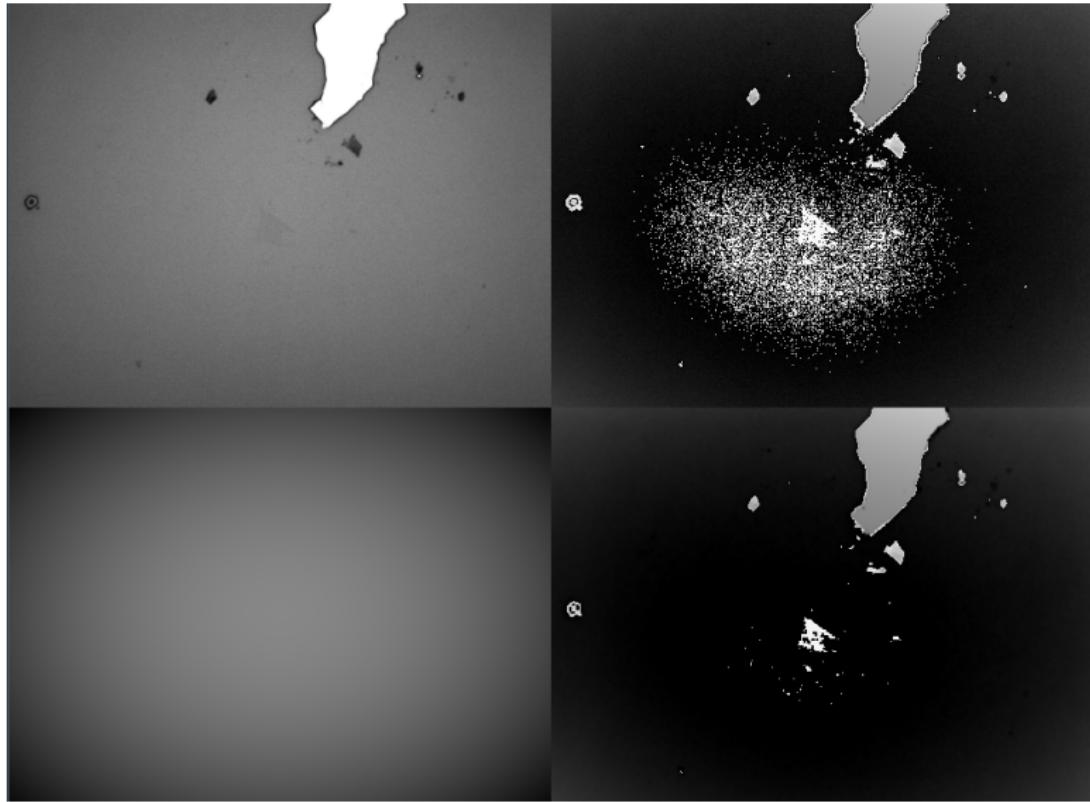
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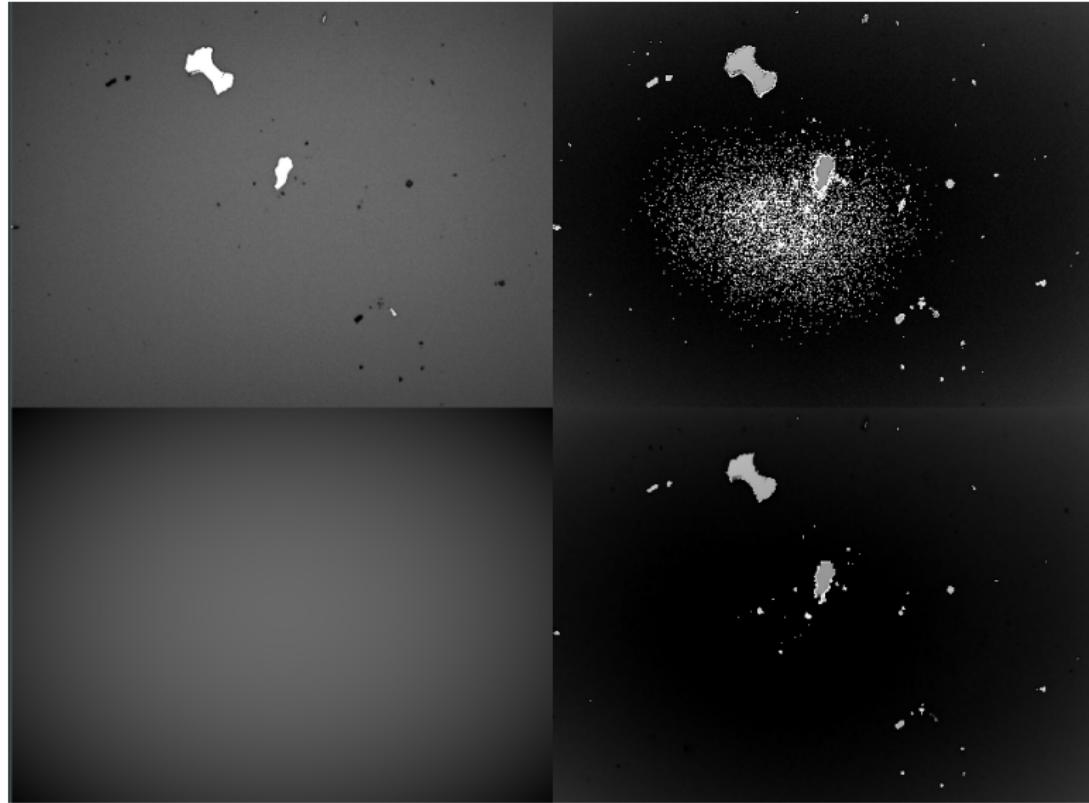
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The morphological transforms were determined by trial and error, adjusting the order of transformation and size of the kernel.

# Denoising Results



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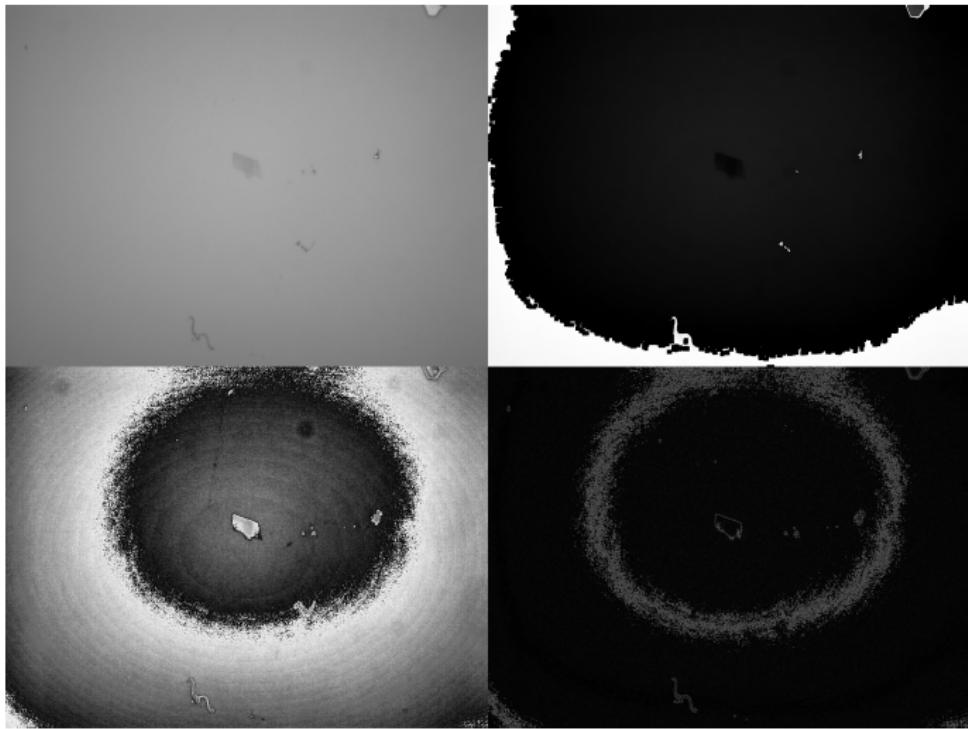
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While I have proposed these methods, I haven't been able to test them as extensively.

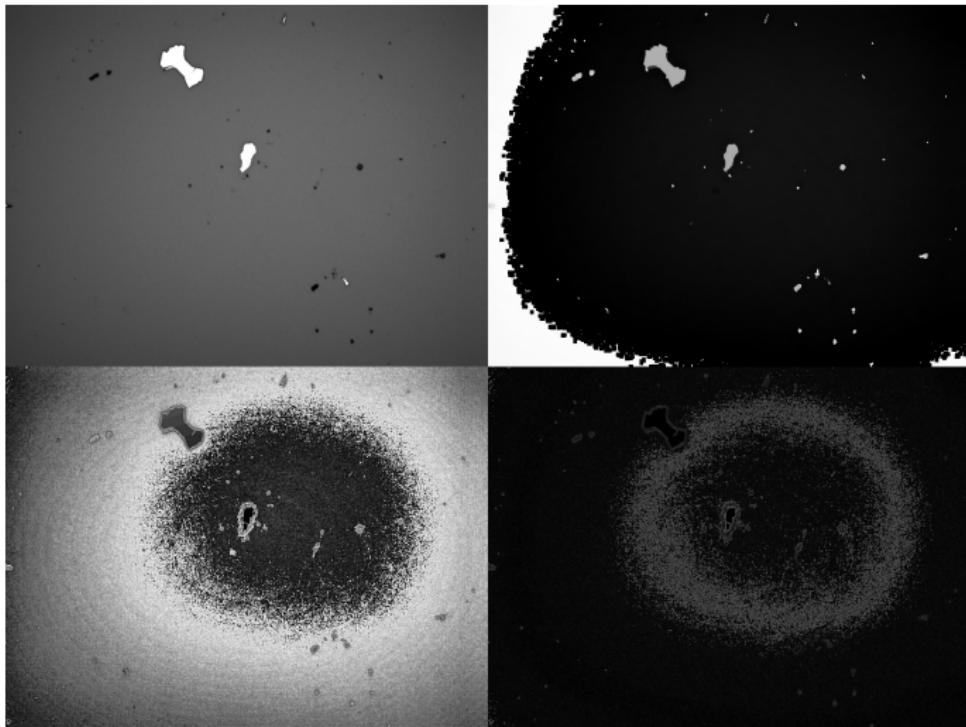
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Morphology, Contrast bump, Sobel Derivative



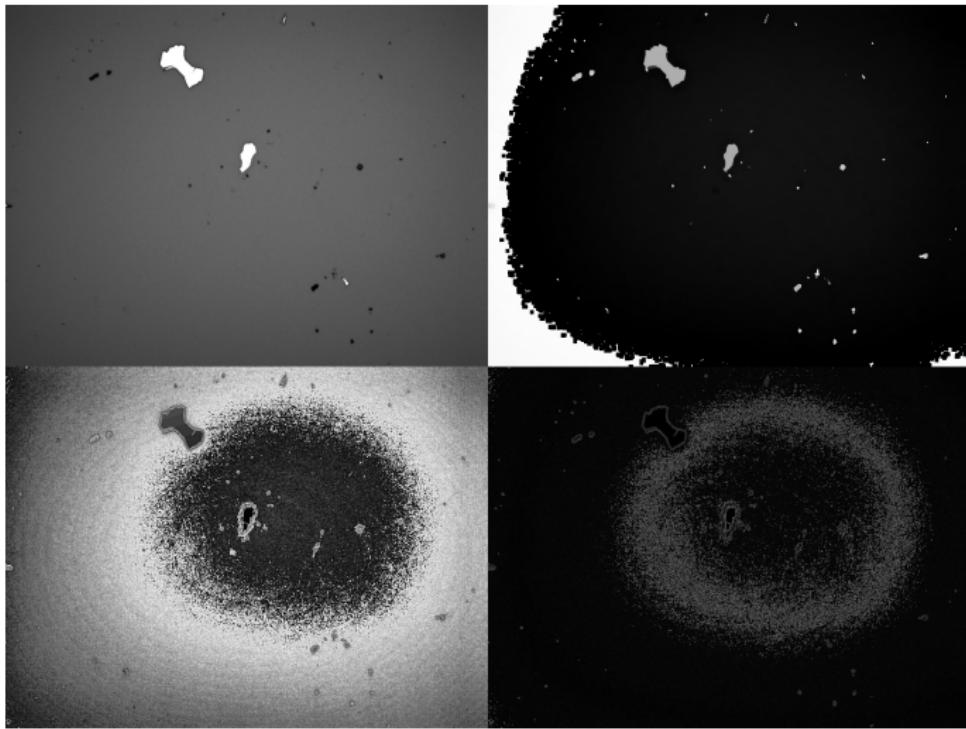
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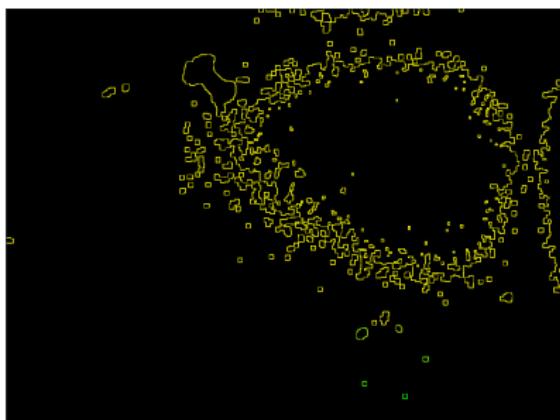
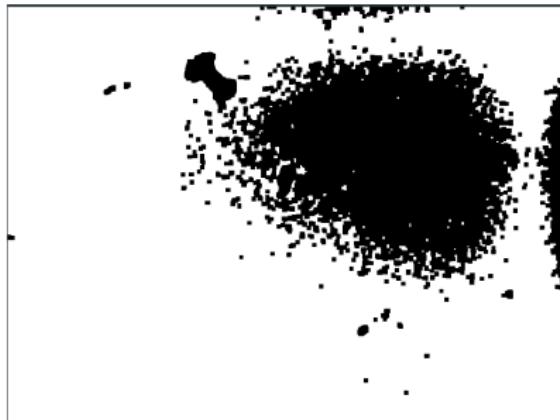
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# Flake Determination Results

Contours



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Background isn't perfectly centred or uniform as assumed.

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- Very low signal to noise ratio—Image stacking?
- Many of the transformations need specified kernel sizes—introduction of “magic numbers”
- The latter half of the program could not be implemented due to issues with the flattening algorithm.
- Alternative colour spaces may be better suited for analysis than the default BGR colourspace.

# Code

<https://github.com/daedalus1235/FlakeAutoFind.git>

Written in C++ using OpenCV, compiled with CMake and g++.