RESOLUTION PART 3: THE 40X OBJECTIVE

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INTRODUCTION:

Commonly bought optical microscopes regularly come equipped with 4 objectives, I mean the 4x 10x 40x and 100x, each one with a different level of resolution, which has been defined: "… as the property of a lens to separate two closed points and make it possible to distinguish them from one another."

In my previous two articles, the level of resolution of two of them, the 4x and 10x was analysed, using chains of streptococcus of yogurt as objects because as far as I am concerned that is the tiniest sample an amateur microscopist is likely to get.

It has also been shown that these two objectives may show discrete objects of a size below the established level of resolution for each objective (although unable to resolve detail in them).

Today´s objective is going to be the 40x plan achromatic, which is ONE OF THE MOST COMMON higher powered objectives used both in amateur and professional observations, see below.

DEVELOPMENT:

According to the formula given before in the previous articles of this series:

$$\text{Resolution} = \frac{\text{wavelength of the light used}}{2 \times \text{numerical aperture}}$$

THE RESOLUTION OF A 40x plan achromatic objective, which has a typical numerical aperture of 0.65, is 0.42 micrometers.

Since we have established that the width of a streptococcus is 0.83 micrometers on average.

Is that resolution sufficient to show detail within a streptococcus sized subject for this objective? I think yes it is, why?

Because when we observe a streptococcus of yogurt with this objective, it is possible to see the chains defined and it is also possible to see with difficulty "inside" each coccus.

However, probably with a big effort with a high power eyepiece it may be possible to see a point inside a coccus of the chain, which would correspond to 0.415 micrometers that is almost the level of resolution obtained with the formula.

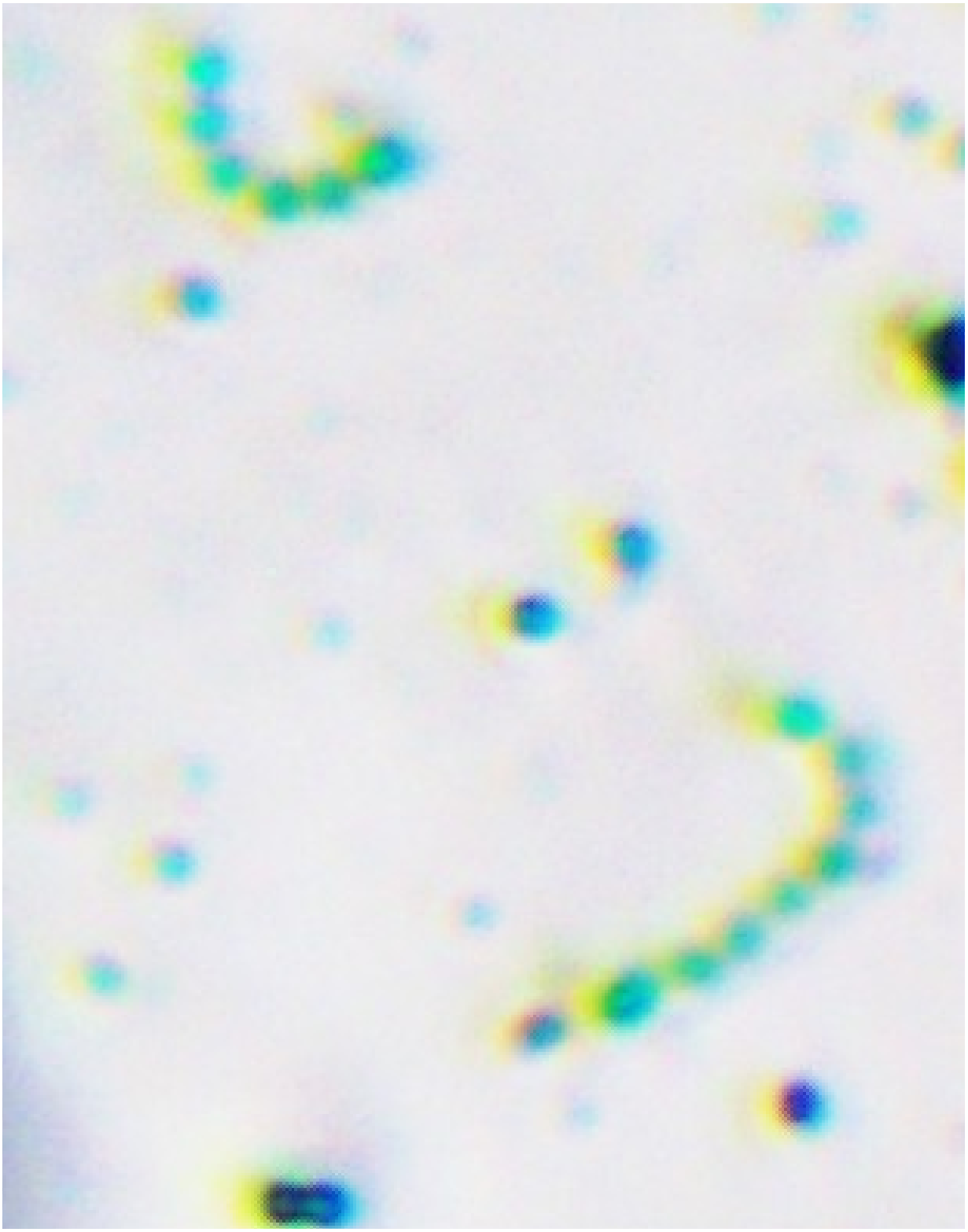
To see a point smaller than this resolution in a coccus of the chain probably with the help of the zoom may be possible to extend that resolution and with a technique, that allows it. *(Editor's note: e.g. by using a monochromatic light source such as deep blue with a wavelength below the 550 nm used to define objective resolution.)*

The question that arises here is:

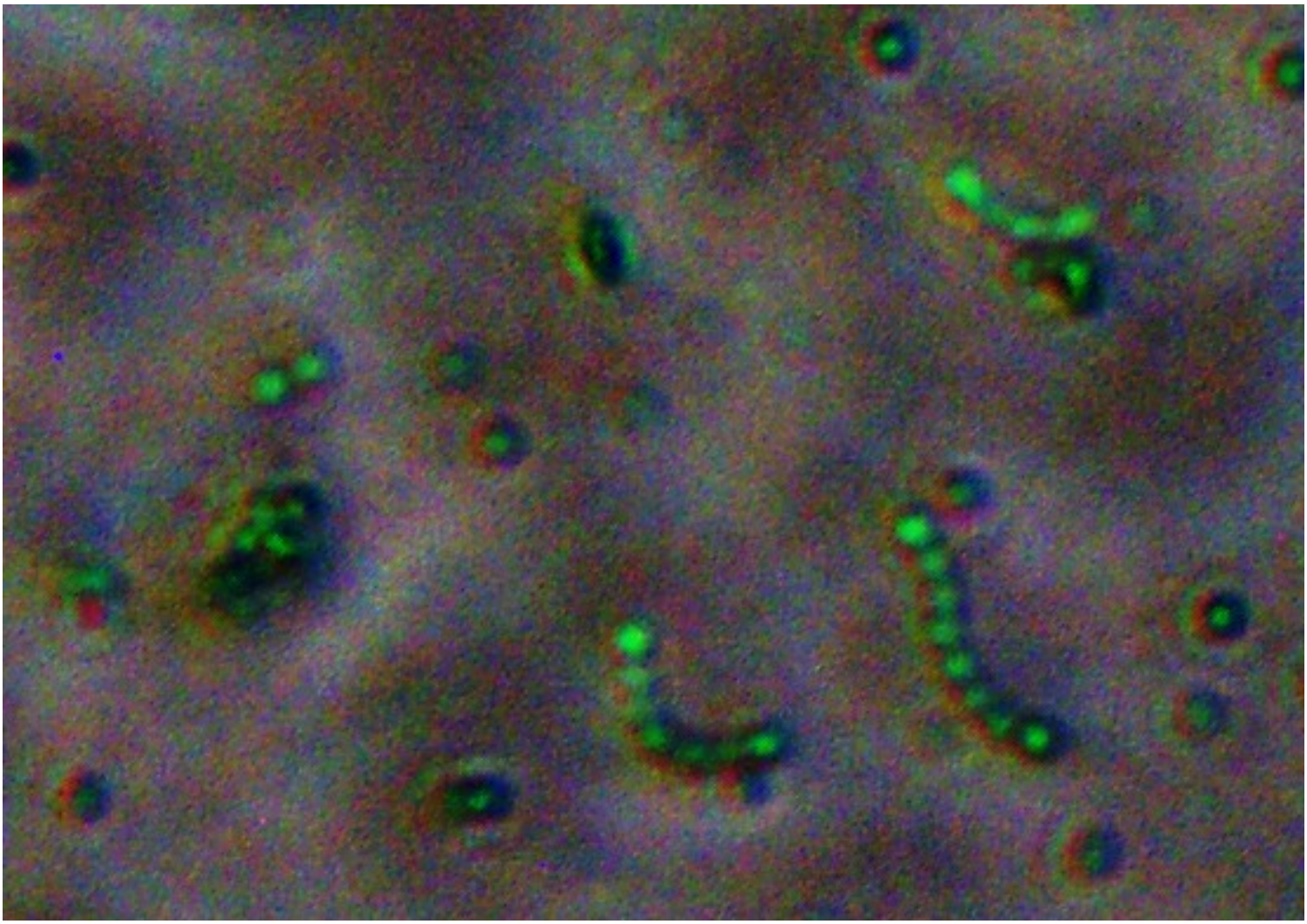
Why the resolution is limited now if the lens is bigger that 4x and 10x explored before that give more resolution than the established for each one.

The answer here is easy, that is because it is not possible to surpass the limit of resolution given by the wavelength of light that is approximately 0.2 micrometers with a plan achromatic objective, and only small detail is seen, in this case the separation of each coccus to define the chain and no more.

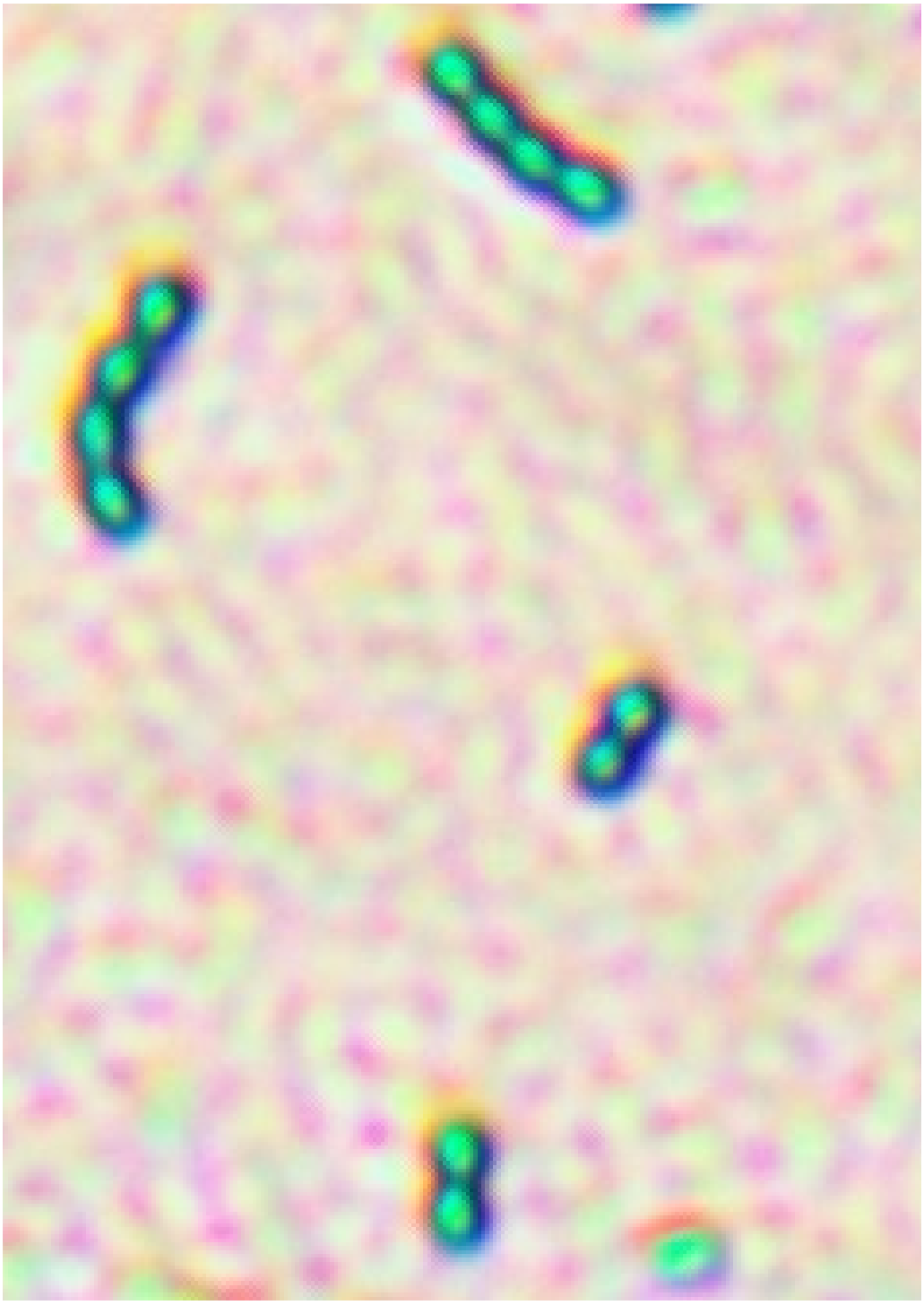
RESULTS:



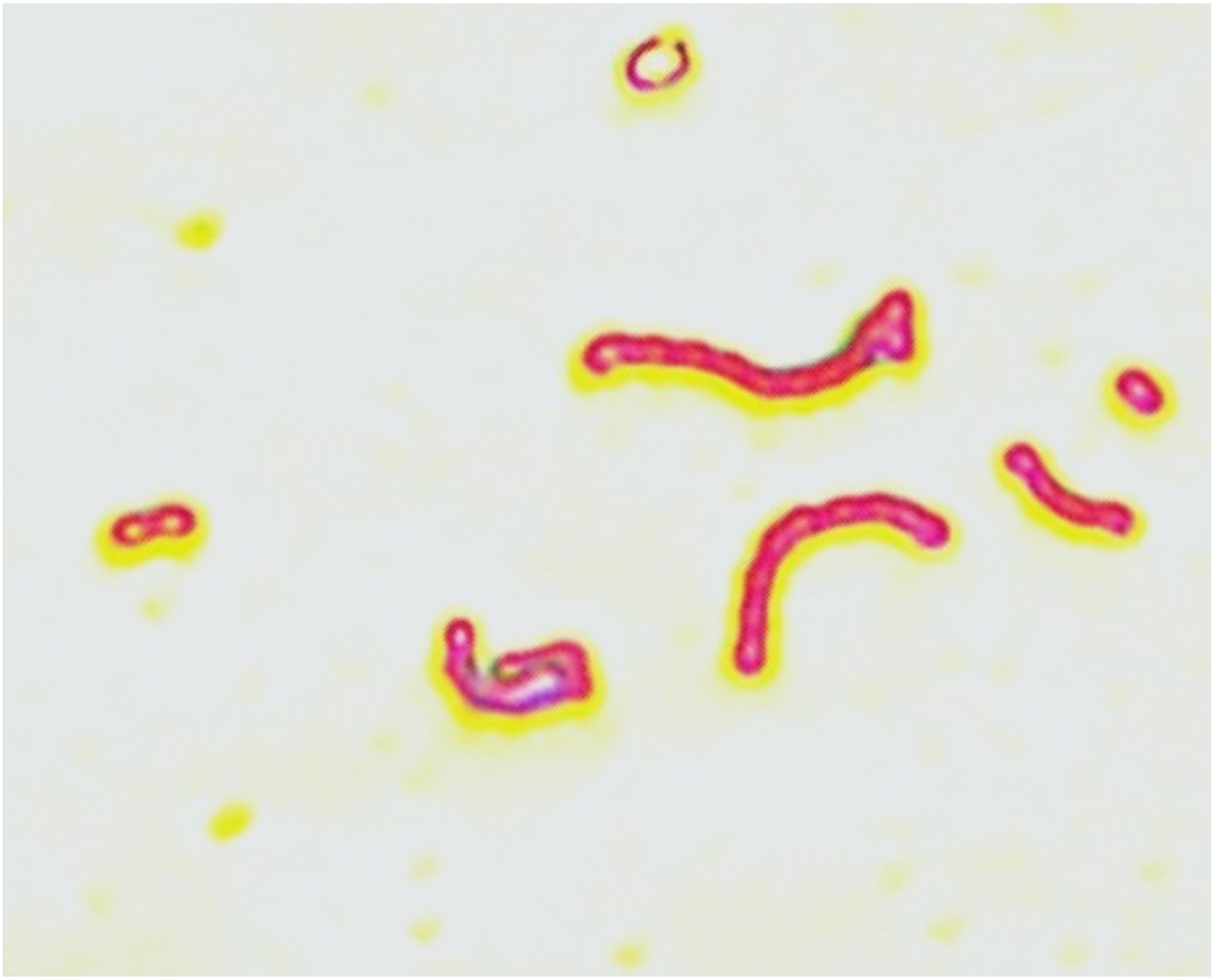
Negative staining with candle soot



Negative staining with candle soot



Streptococcus of yogurt stained with methylene blue



Streptococcus of yogurt stained with gentian violet.

CONCLUSION:

As it is shown above, this is the farthest we can go as amateur microscopists with a “common” optical microscope using white light and with the most common “higher power” objective found almost everywhere and that does not need any immersion oil.

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(Above in anti-spam format. Copy string to email software, remove spaces and manually insert the capitalised characters.)

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