

Accretion Disk & Magnetic Field



Contents

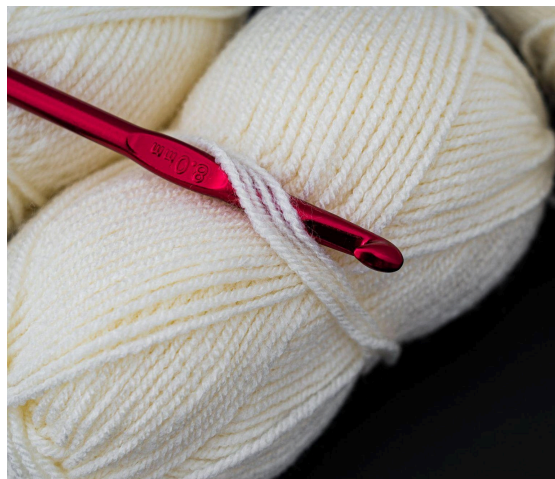
| | |
|----------------------------------|----------|
| Introduction | 3 |
| Yarn & Hooks | 3 |
| Abbreviations | 4 |
| What are Accretion Disks? | 5 |
| Accretion Disk Pattern | 6 |

Introduction

This booklet is for the early-stage protoplanetary disk that is part of *Crochet The Universe*: a series of patterns for various space-y physics concepts for you to crochet. The idea behind the patterns is for higher level physics concepts such as black holes to be made into easily visualisable and holdable models that can be used for classroom demonstrations, or they can be made just for fun!

Yarn & Hooks

The disk, when finished, is small enough to be held with one hand, however the size is completely up to you. You are welcome to use any weight of yarn and any hook that makes your stitches nice and tight, as **there is no need to gauge swatch**. Expect a larger model when using aran and chunky yarn, and a smaller one when using sport/fingering etc.



The model in this book used dk weight acrylic yarn (**Stylecraft Special dk**) with a 4 mm (US G) hook. Once again, use whatever size and hook you please, this isn't to-scale anyways!

Almost all types of yarn are suitable for this. Stylecraft special dk was chosen as it is usually the most affordable option, but I highly recommend going through your stash for small balls from previous projects.

For the accretion disk, I used the following colours:

1123 - Claret

1711 - Spice

1002 - Black

Abbreviations

All patterns are in **US terms** and with standard crochet abbreviations. A list will be provided below as a reminder:

sc single crochet

dc double crochet

hdc half-double crochet

sl-st slip-stitch

ch chain

hdc2tog half-double crochet 2 together

sc2tog single crochet 2 together

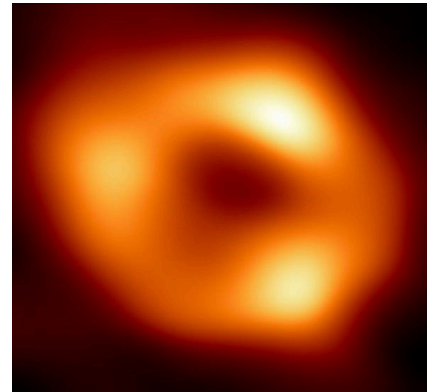
Accretion Disk

What is an Accretion Disk?

Accretion disks are disks of high energy gas orbiting a massive star or a black hole. The material in the disk moves at extremely fast speeds, so friction between the gas particles causes them to heat up and emit radiation, giving them their orange glow.

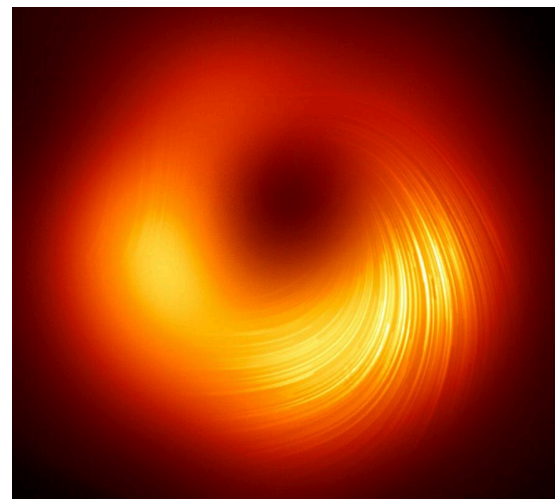
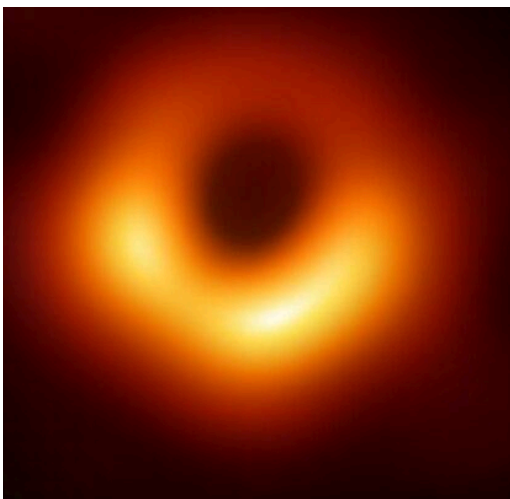
Sgr A* & M87

The supermassive black hole in the centre of our own galaxy is Sgr A*, and is around 4 million solar masses (i.e 4 million times more massive than our Sun). Surprisingly, it's actually quite small for a supermassive black hole, with many of them having masses in the billions of solar masses!



Sgr A* is the image on the right.

The Event Horizon Telescope (EHT) took the first ever images of a black hole in 2017, one of Messier 87's black hole and one of the Milky Way's black hole (Sgr A*). It took 8 radio telescopes to get the right resolution to image the black holes clearly, and are some of the most ground-breaking space images to date! M87's image is on down below on the left, and on the right is an image of the polarised light. This image also marks the first time astrophysicists have been able to measure polarisation to such detail, which is useful for seeing what the magnetic field looks like.



References:

J. Frank; A. King; D. Raine, *Accretion Power in Astrophysics*, 3rd Edition, 2002.

Images are credited to [the EHT collaboration/ESO](https://www.eht.imaging.science/).

Pattern Instructions

The pattern starts off with crocheting the supermassive black hole. The disk is made flat as a ribbed parallelogram, which is then sew into a tube, then stuffed and joined into a disk shape.

The disk is then sewn onto the black hole.

The chain does not count as the first stitch in this pattern, so please remember to not skip the first stitch!



Supermassive Black Hole

Using **black**, make a magic loop and create 6 sc in the loop.

Round 1: Chain 1, make 2sc in each sc, slip stitch into the first sc (12sts)

Round 2: Chain 1, *make 2sc in the first sc, 1sc in the next stitch * repeat 5 more times and slip into the first stitch (18 sts)

Round 3: Chain 1, *make 2sc in the first stitch, 1 sc in the next 2 stitches * repeat more times and slip into the first stitch (24 sts)

Round 4 & 5: Chain 1, Make 1sc in each stitch and slip into the first stitch (24sts)

Round 6: Chain 1, Make 1sc in the back loop of each stitch and slip into the first stitch (24sts) (this back loop row will leave the front loops open for making the disk)

Round 7: Chain 1, Make 1sc in each stitch and slip into the first stitch (24sts)

Round 8: Chain 1, *make 1 sc2tog, then make 1 sc in each of the next 2 stitches* repeat 5 more times and slip into the first stitch (18 sts)



Begin stuffing the black hole at this point.

Round 9: Chain 1 *make 1 sc2tog, then make 1 sc in the next stitch * repeat 5 more times and slip into the first stitch (12 sts)

Round 10: Chain 1, make 6 sc2tog and slip into the first stitch, cut the yarn with a long tail and stitch the 6 sc2tog stitches closed together.

The Accretion Disk

The accretion disk uses 2 colours, red and orange, which alternate every 2 rows to create the swirl. The disk is worked flat in a slanted manner in the back loop to create the magnetic field lines a.k.a the ridges. Chains at the start of the round do not count as stitches.

Using **orange**:

Make a slip knot and chain 20 stitches.

1st row: chain 1, 1sc in back loop of the first stitch, make 1 sc2tog in the back loop of the next 2 stitches, make 1 sc in back loop of each stitch up to the last 2 stitches, make 2sc in back loop of next stitch, 1sc in back loop of last stitch, turn work (20 sts)

2nd row: chain 1, 1sc in back loop of the first stitch, make 2sc in the back loop of the next stitch, make 1 sc in back loop of each stitch up to the last 3 stitches of row, make 1 sc2tog in back loop, 1sc in back loop of last stitch but pull last loop with **red** (20 sts)



Do not cut the orange yarn.

3rd row: chain 1, 1sc in back loop of the first stitch, make 1 sc2tog in the back loop of the next 2 stitches, make 1 sc in back loop of each stitch up to the last 2 stitches, make 2sc in back loop of next stitch, 1sc in back loop of last stitch, turn work (20 sts)

4th row: chain 1, 1sc in back loop of the first stitch, make 2sc in the back loop of the next stitch, make 1 sc in back loop of each stitch up to the last 3 stitches of row, make 1 sc2tog in back loop, 1sc in back loop of last stitch but pull last loop with **orange** (20 sts)

Do not cut the red yarn.

Repeat rows 1-4 11 more times, resulting in 48 rows, pull the red yarn through and cut a long tail.



You will hopefully have a parallelogram of striped red and orange fabric. It should also be quite stretchy, which will help to make the smooth doughnut shape.

Connect and sew the 2 shorter sides into a tube. Tip: To keep the ridged shape, sew only the front loops together.



The Join

Using the **orange** yarn and working along one end of the tube, make a standing sc2tog using the left and right side of any ridge, repeat for all stripes, pull through the yarn and cut a very long tail. (24 sts)



Repeat for the other side of the tube. Add a small amount of stuffing to the disk.

Using a tapestry needle, take one tail and sew the rows of sc2tog together, leaving one round of loops free in order to stitch the disk to the black hole.



Take the other tail and sew through both the front loops from row 6 of the black hole and the loops from the accretion disk. Weave in any loose ends and admire your accretion disk!

