Reconstructing 3D magnetic topology of on-disk solar prominence bubbles

May 26 2021, by Li Yuan

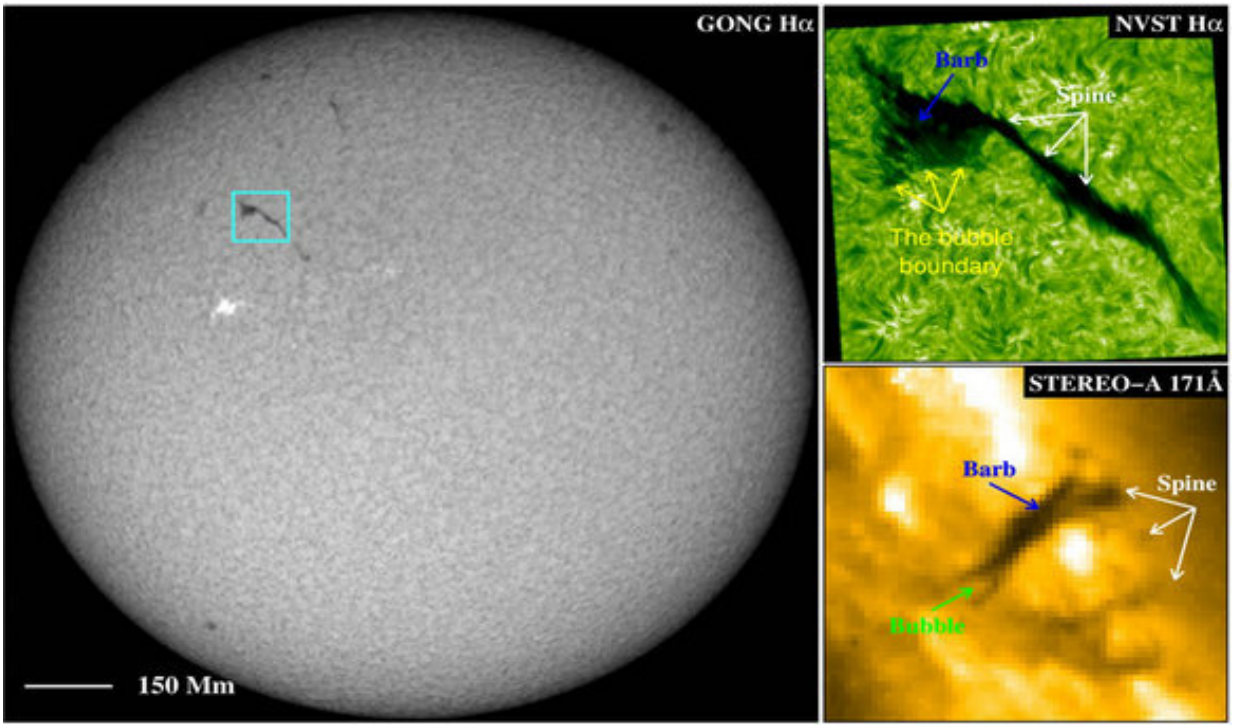

Fig. 1 Overview of the on-disk bubble. Credit: GUO Yilin

Solar prominences or filaments are cool and dense plasma structures suspended in the hot and tenuous corona.

Recent high-resolution solar limb observations reveal that some dark "bubbles" with bright arch-like boundaries form below prominences. It

is puzzling that how these bubbles, semi-circular voids, form below dense prominences.

Ph.D. student Guo Yilin from National Astronomical Observatories of Chinese Academy of Sciences (NAOC), together with Dr. Hou Yijun, Dr. Li Ting, and Prof. Zhang Jun, found and investigated an on-disk bubble based on stereoscopic observations for the first time.

The study was published in the *Astrophysical Journal Letters*.

It is widely accepted that bubbles are closely related to the overlying prominence system and could eventually lead to the generation of a coronal mass ejection. This has serious effect on space weather.

"However, previous studies are all based on the solar limb observations or numerical simulations. If the bubble could be found on the solar disk, we could unveil the magnetic nature of the bubble," said Dr. Hou Yijun, the corresponding author of the study.

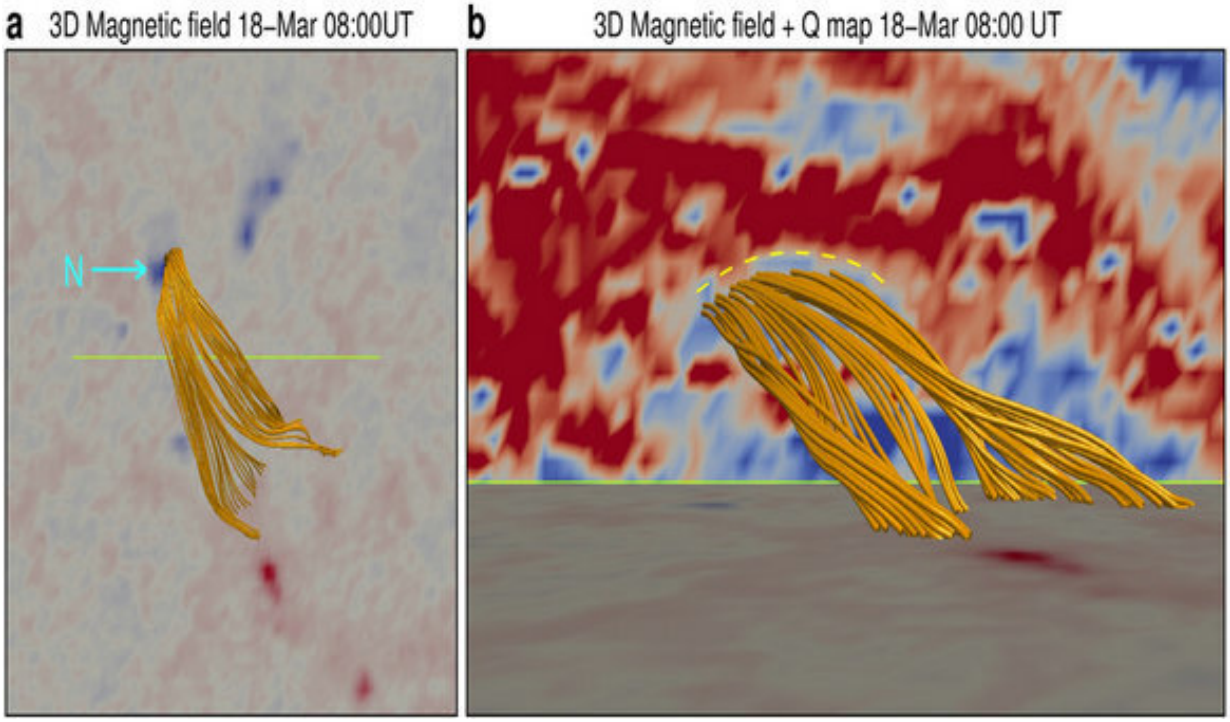

Fig. 2 3D magnetic topology of the on-disk bubble. Credit: GUO Yilin

Checking high-resolution images from New Vacuum Solar Telescope (NVST), the researchers found an on-disk bubble with a sharp arch-like boundary around a filament barb.

"Fortunately, this bubble can be simultaneously observed by Spacecraft-A of the Solar TErrestrial RElations Observatory (STEREO-A). Therefore, based on stereoscopic observations, we reconstruct the 3D structure of bubble boundary," said Guo Yilin, the first author of the study.

Then, based on photospheric vector field observations, the researchers further reconstructed 3D magnetic fields and calculate the squashing factor Q map. The Q map depicts a distinct arch-shaped interface.

The interface agrees well with the 3D structure of the bubble boundary. Under the interface lies a set of magnetic loops, which are rooted on a surrounding photospheric magnetic patch (N).

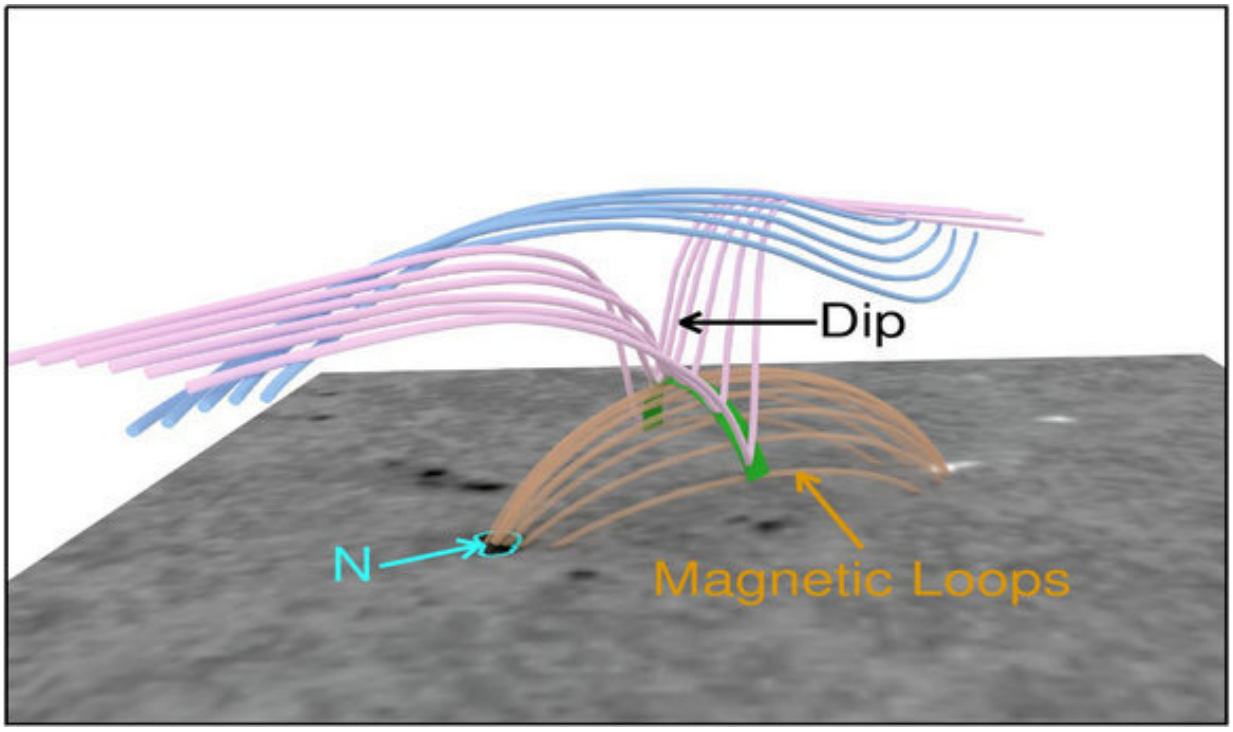

Fig. 3 Cartoon model of the bubble-prominence dip system. Credit: GUO Yilin

These results indicate that the prominence (filament) dips (barb) interact with the underlying magnetic loops at some locations. Then, an arch-shaped interface is formed. The interface corresponds to the bubble boundary. Therefore, it is reasonable to speculate that the bubble can form around a filament barb below which there is a photospheric magnetic patch.

"The on-disk bubble is probably not a rare structure. Further studies on

on-disk bubble will hopefully answer the key question of whether the bubbles form from flux emergence below a pre-existing prominence, and are important for better understanding of the magnetic topology and dynamic evolution of prominences (filaments)," said Dr. Hou Yijun.

More information: Yilin Guo et al, Reconstructing 3D Magnetic Topology of On-disk Prominence Bubbles from Stereoscopic Observations, *The Astrophysical Journal Letters* (2021). DOI: 10.3847/2041-8213/abee92

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