The recovery of shape information from image data is a central problem in computer vision, and decades of research have led to the development of computational tools for inferring shape from a variety of visual cues, including shading, texture, color, and shadows. An important visual cue for shape is specular reflection. Specular (mirror-like) surfaces are abundant in both natural and man-made environments. Metal, glass, the wavy surface of a pond, and glazed ceramics are a few examples.

Specular surfaces reflect incident light toward an observer without attenuation, and when they are curved, they present a distorted version of their illumination environment that contains very rich information about their shape. While perceptual studies suggest that humans make use of this visual cue, the underlying mechanisms are not yet known, and computational tools for inferring shape from specular reflections under real-world illumination do not yet exist. Instead, due to the complexity of the relationship between a specular shape and its images, previous analysis has been limited to controlled, unnatural environments and/or very limited types of surfaces.

This project moves in a different direction by specifically considering arbitrary smooth surfaces in uncontrolled, real-world illumination conditions. This seemingly difficult task is made manageable by a novel approach with two key components: 1) the consideration of far-field illumination environments in which the environment-surface distance is large relative to the relief of the surface; and 2) the analysis of 'specular flow'---the dense motion field on the image plane that is induced by the relative movement between a specular surface and its environment. This approach provides a unique balance between tractability and practical validity, and it may be a pivotal step in furthering our understanding of a powerful visual cue.

This is a collaborative project with Ohad Ben-Shahar at Ben-Gurion University of the Negev.