Activity: A Problem of Bent Light

Two human astronauts in spacecraft (air-capable) are exploring a very distant planet, where they find a fish-like creature who is swimming a few meters beneath the surface of a (clear) alien ocean. At the exact point in time of this exercise, one astronaut (1) is flying through a point just above the surface, directly above the creature. The other one (2) is simultaneously flying at a point at the same height over the ocean, but at a steep angle off perpendicular to the line between the other astronaut and the extraterrestrial creature, who is peering up at the two strange craft. [Problem adapted from UAlbany ITLAL early career institute, August 2014.]

Which of the three is most likely to have the best view optically (for locating purposes) of his/her/its target? And be prepared to explain your reasoning!

A. Fish looking at Astronaut 1

B. Fish looking at Astronaut 2

C. Astronaut 1 looking at Fish

D. Astronaut 2 looking at Fish

ALSO: How would your answer change if the astronauts could use x-rays instead of only relying upon their human eyes, and the creature’s outermost layer reflected x-rays?

Bonus: What substance could the scales of the alien “fish” be made out of that would make x-ray “vision” fail? Explain the mechanism.