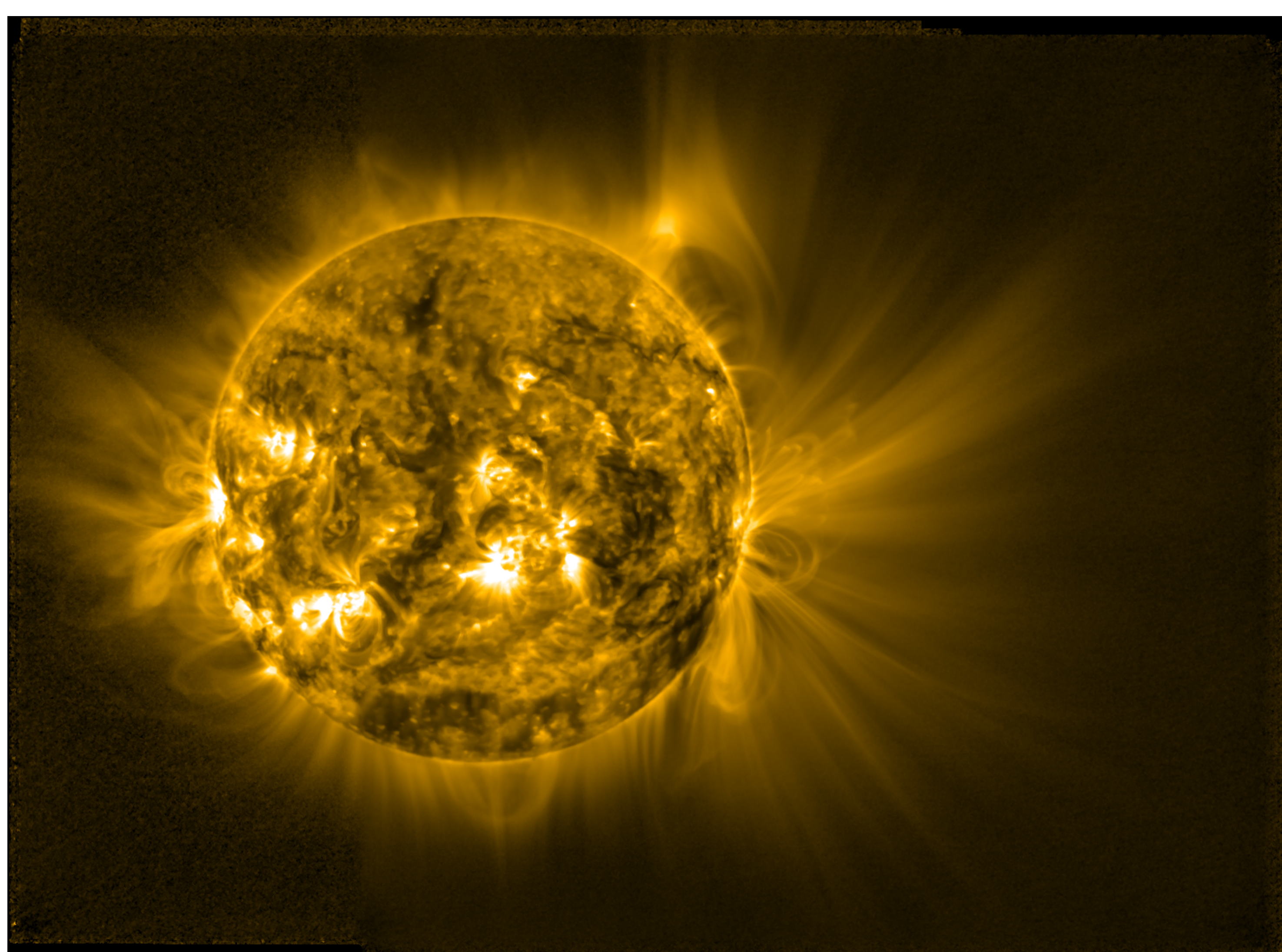# COHERENT
COrona as a Holistic Environment REsearch NeTwork

Amir Caspi (SwRI), Daniel B. Seaton (CU/CIRES & NOAA/NCEI), Traci Case (SwRI), Mark Cheung (LMSAL), Steven Cranmer (CU/APS), Craig E. DeForest (SwRI), Giuliana de Toma (NCAR/HAO), Cooper Downs (PSI), Heather Elliott (SwRI), Anne U. Gold (CU/CIRES), Dana Longcope (MSU), Sabrina L. Savage (NASA/MSFC), Susan Sullivan (CU/CIRES), Nicholeen Viall (NASA/GSFC), Angelos Vourlidas (JHU/APL), and Matthew J. West (ROB)

Motivation

COHERENT is a research collaboration dedicated to developing capacity to understand the solar corona as a holistic system and to facilitate cross-cutting, creative, and equitable research frameworks.

There is a clear need for such an integrated approach because, although the solar corona and heliosphere (i.e., the extension of the corona into and throughout interplanetary space) *must* be part of a single physical system, attempts to study even the various elements of the low corona alone as a self-contained whole have been extremely limited. One reason for this is that the dominant physical processes change dramatically from the magnetically-dominated low corona, through the so-called middle corona, and into the plasma flow-dominated outer corona and heliospheric interface. These widely disparate plasma regimes require distinct measurement techniques, leading to a lack of observations that cohesively and continuously span this wide range of parameter space. Likewise, computational capabilities have only recently advanced sufficiently to allow unified models that simultaneously include, with equal consideration, the dominant processes and relevant spatiotemporal scales from each regime. This lack of unifying observations and models has led to a fragmentation of the community into distinct regimes of plasma parameter space, with groups typically working in relative isolation.


COHERENT closes this gap, enabling transformative science progress, by bringing together experts spanning multiple disciplines to bridge the divisions be-ween these various systems, working collaboratively to develop new tools, observation sets, models, and frameworks for communication and collaboration. COHERENT realizes its goals by addressing three interconnected science objectives:

Determine and characterize the feedback and cross-scale connectivity between (1) initiation and propagation of impulsive processes and (2) quasi-continual processes, and the structure of the solar corona from surface to interface with the heliosphere; and (3) how these processes interact with and affect one another in the context of global coronal structure.

Research Directions

COHERENT partitions its research efforts into three initial working groups. **WG1** looks at the various processes responsible for heating the corona and accelerating the solar wind and how these processes both shape and are influenced by the corona on large scales.
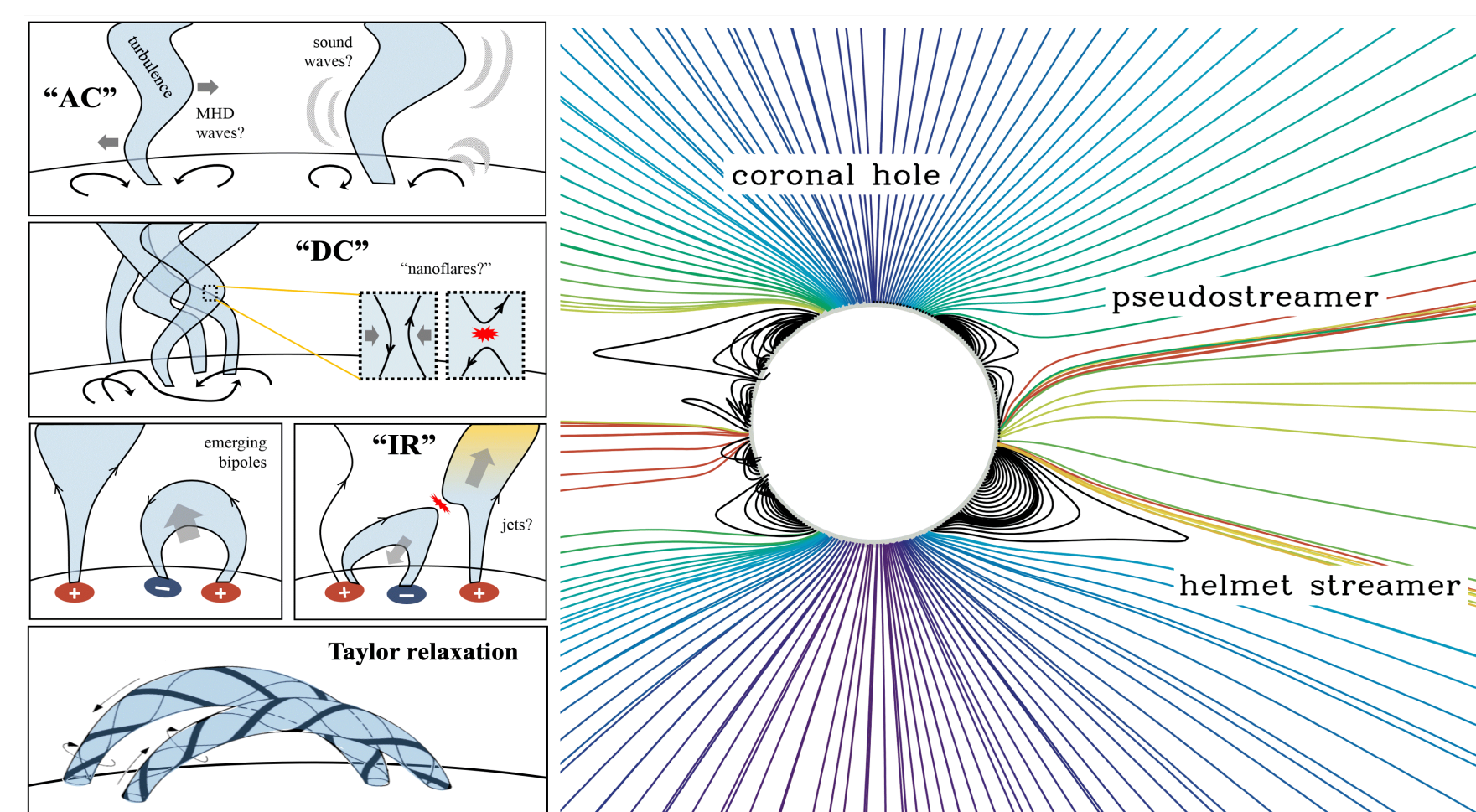

For example, proposed coronal heating mechanisms, including waves/turbulence (AC), slow footpoint motions punctuated by impulsive nanoflare reconnections (DC), exchange of mass and energy between closed and open regions (IR), and MHD evolution via helicity conservation in twisted fields ("Taylor relaxation") all probably are dominant in different areas of the large scale coronal structure (right).

WG2 examines the role of magnetic reconnection in driving dynamic processes on multiple scales and how reconnection both heats and shapes the corona. This WG studies the origins and characteristics of downflows above post-eruptive arcades observed by TRACE (Panels A & B) and at much larger heights in coronal streamers (Panel C). Leveraging simple reconnection models (Panel D) we explore characteristics of reconnection-related outflows (shown schematically in Panel E and the conditions in which they occur. Linking both observations and reconnection models to global models of the corona allows us to determine how reconnection modulates the corona's shape, temperature, and other characteristics.
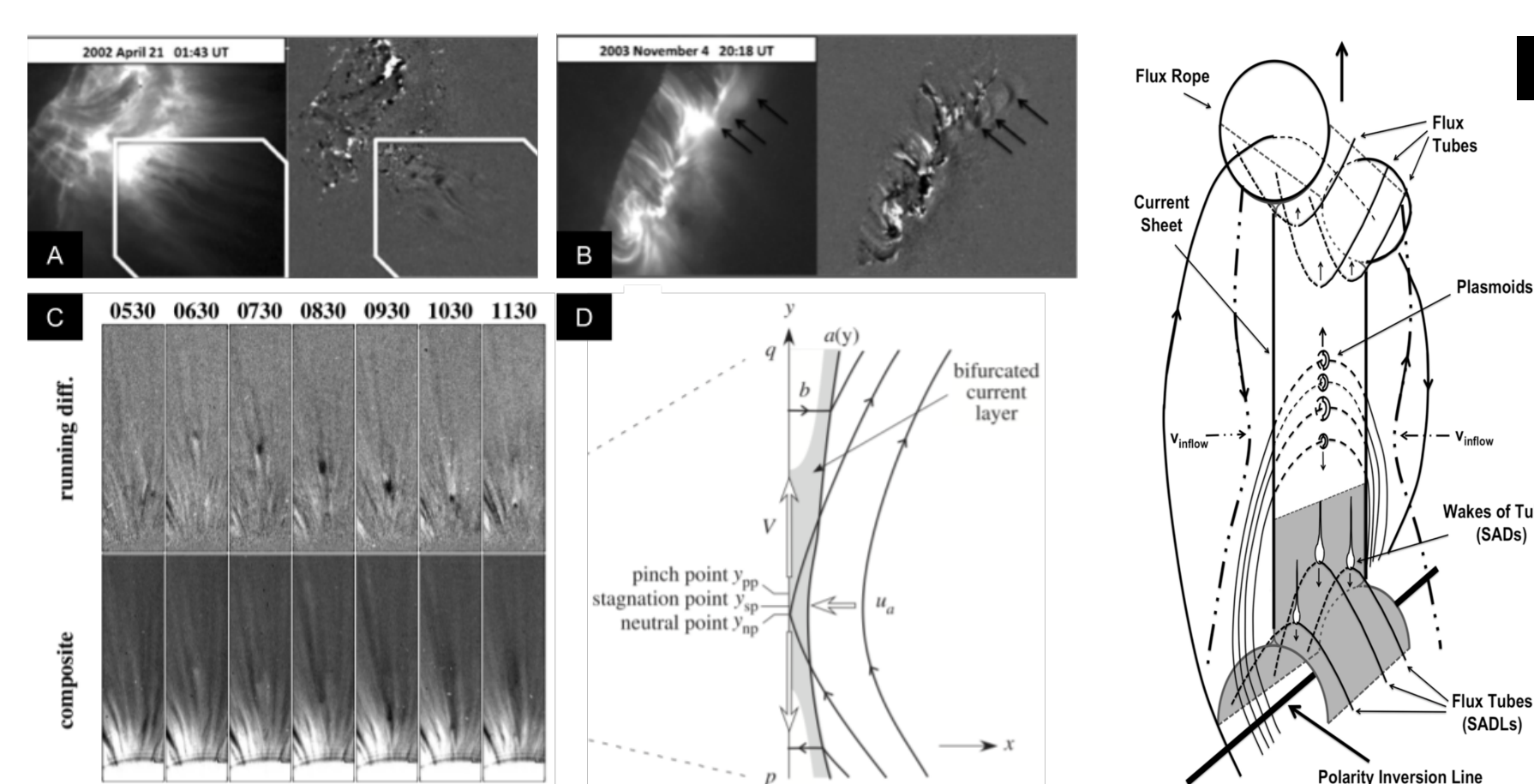
WG3 explores the large-scale connectivity of the corona, examining how connections between the low corona and heliosphere are formed by both dynamic processes and quasi-stationary phenomena that bridge these two regions. This working group leverages large-scale observations, such as those from eclipses (left) that reveal the complex structure of the corona and deep field coronagraph images (right) that reveal transient flows linked to the solar wind.
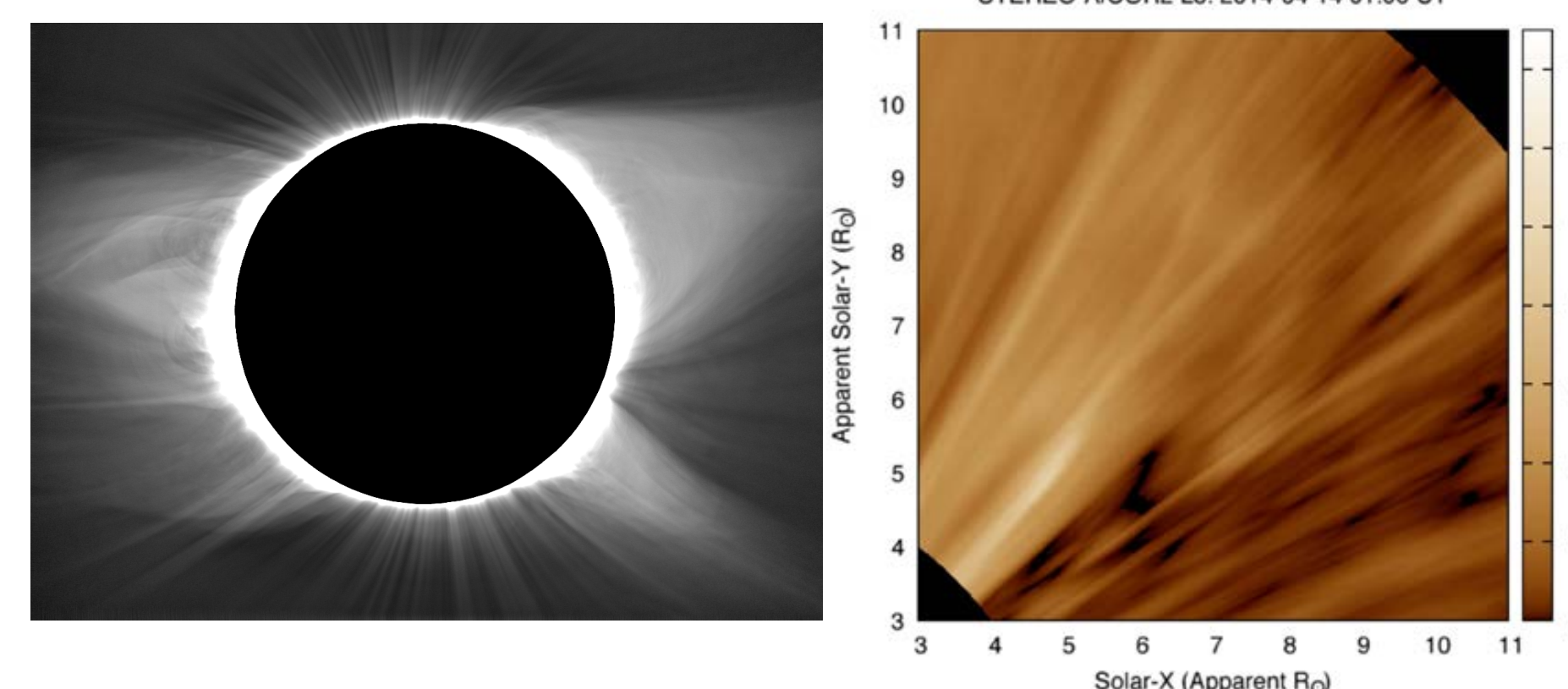

The exact nature of the connection between drivers in the low corona corresponding solar wind streams at the top of the corona remains unknown. Likewise, the group will address whether large- or small-scale features are more significant in determining this connectivity.

Implementation

Center Vision: COHERENT aspires to create a holistic understanding of how energy, mass, and information propagate throughout the solar corona, from the Sun's surface to the heliosphere and back, by knitting together novel approaches to theory, modeling, and observations within a collaborative and highly interconnected research framework. We enable this unified understanding of the disparate physical regimes in the corona by developing new tools for cross-disciplinary scientific analysis, modeling, team communication, and interaction. This cross-disciplinary approach breaks down stovepiping that impedes transformative progress and resulting breakthrough science in heliophysics.

COHERENT's vision overlies four mutually-reinforcing strategic pillars — Define, Research, Communicate, Innovate — that foster creativity, innovation, and equity. We leverage an iterative research process that allows us to develop and refine scientific goals to maximize impact and success and mitigate risk in developing breakthrough science. We work to engage the whole community through dedicated, focused two-way communication.

Mapping coronal magnetic fields
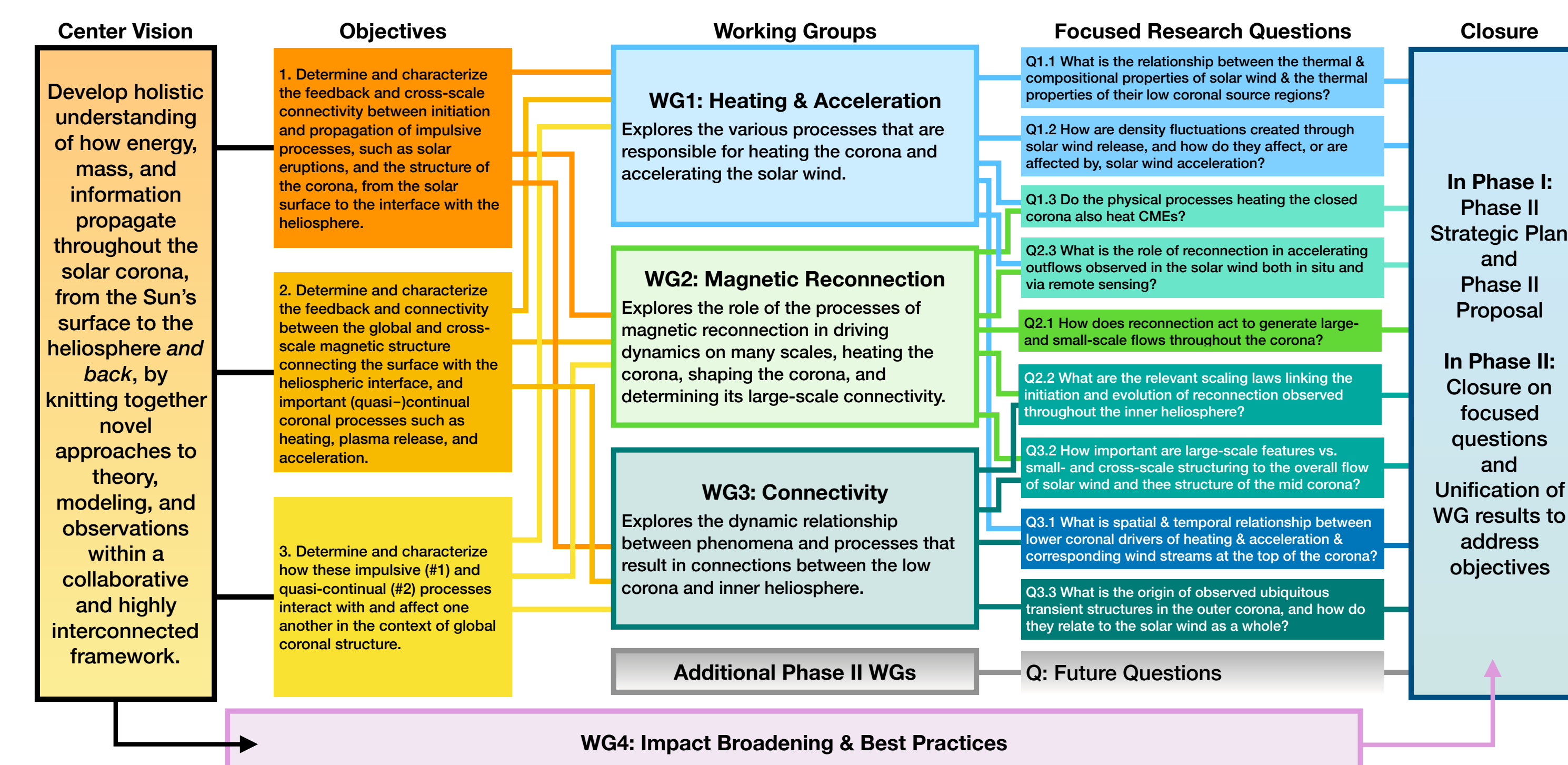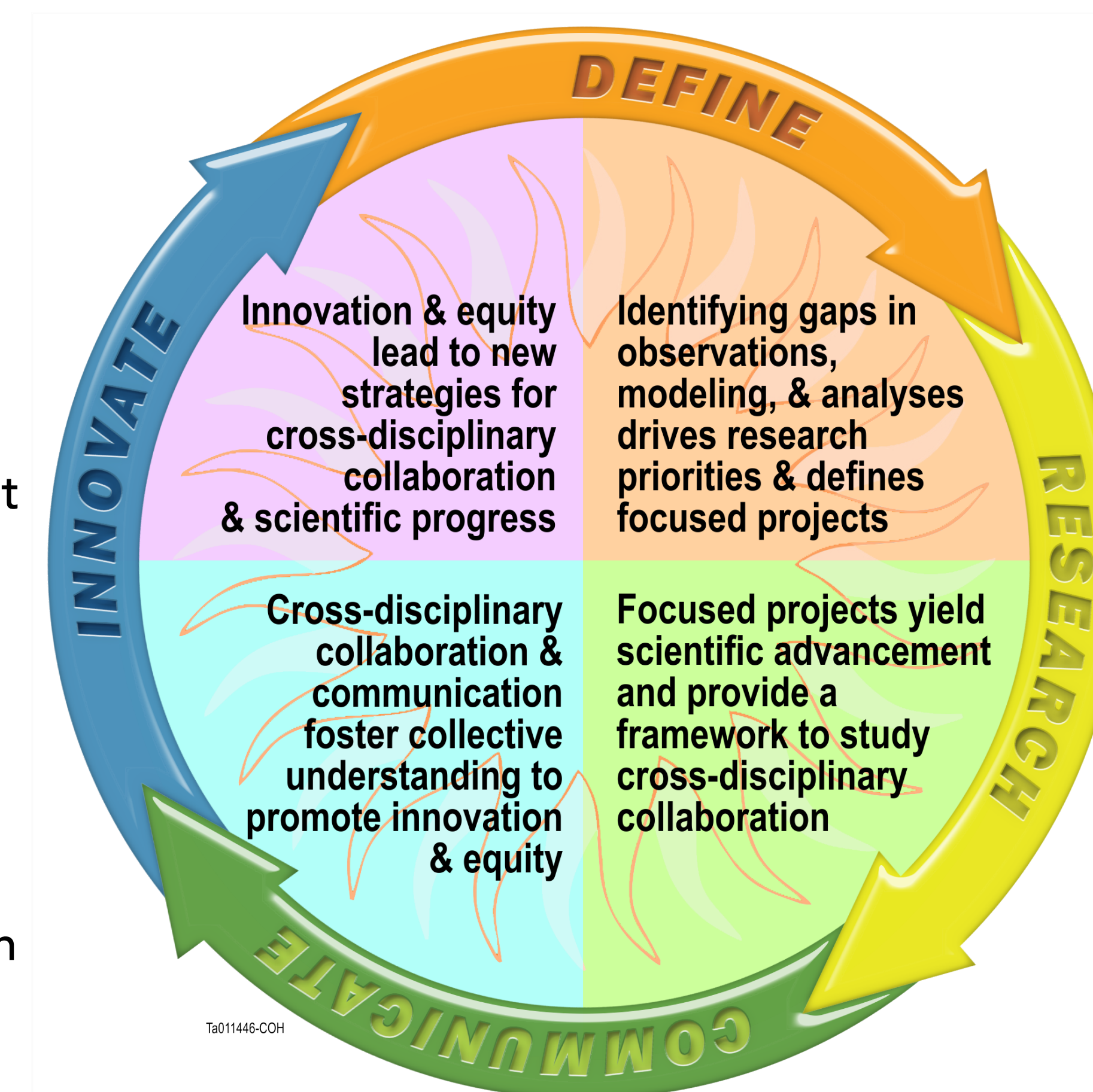
COHERENT's interconnected science goals flow from the Center vision and provide a clear, flexible, two-phase framework that can easily accommodate growth and redirection towards successful efforts. COHERENT believes **impact broadening elements are essential to the success of cross-disciplinary research programs and dedicates a working group to activities that foster equity and improve engagement across the scientific community.** This group also develops metrics for success to evaluate and improve the use of evidence-based best practices for interdisciplinary research.